UNIVERSITY OF BRISTOL.

THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station

(THE NATIONAL FRUIT AND CIDER INSTITUTE),

LONG ASHTON, BRISTOL,

1922.

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INTRODUCTION.

Although the year 1922 has not been characterised by any outstanding development in the shape of staff, buildings or land, it is likely that various decisions which have been arrived at during the year will materially influence the course of the future work of the Institute. As indicated in the last Report, further active extension of the work was impossible without increased financial aid. During the year the Ministry of Agriculture and Fisheries has secured additional funds for the development of agricultural research and has allocated a grant of £5000 towards the cost of buildings, equipment and development of land for experimental work, needed before extension can be undertaken. From the same source an increase in the annual grant has been provided, which permits of certain additions to the Staff, the initiation of a scheme of research on Willow growing and the utilisation of willows, and the beginning of a systematic survey of soils in respect of their suitability for fruit culture. These matters have been referred to in more detail below.

An important step has been taken by the institutions engaged in horticultural research which are aided by grants from the Ministry of Agriculture and Fisheries. Hitherto there has been no settled procedure with regard to the publication of results, some of which have been dealt with in the form of summarised progress reports of the present character issued annually by the institutions and others in more detailed communications to various scientific and technical journals. The need of a special periodical to serve as a medium of publication of the work of these institutions has been apparent for some time and recently it has been possible to arrange with Mr. Edward A. Bunyard, F.L.S., for the Journal of Pomology, hitherto owned and edited by him, to fulfil this purpose. The institutions concerned have taken over all financial responsiblity and the publication will in future appear under the name of the Journal of Pomology and Horticultural Science, Mr. Bunyard continuing to act as editor. This arrangement will to some extent affect the character of the Annual Reports of this Station. The greatly increased annual output of work since its extension in 1912 calls for more space than can here be devoted to it. Hence the reports have gradually

assumed the character of summarised progress statements relating to some of the subjects under investigation, with occasional articles in greater detail. The complete papers on many subjects have been necessarily published elsewhere. It is proposed to proceed in future along this line of natural development. Succeeding reports will therefore consist mainly of brief summaries of papers published in the Journal of Pomology and Horticultural Science and other technical journals and of reprints in complete or abridged form of any which it is desired to reproduce more fully. Any readers who wish to see the fully recorded work can obtain further information relating to the Journal named from the Station.

Staff.—Mr. S. P. Wiltshire, having accepted an appointment on the staff of the Imperial Bureau of Mycology, vacated his post as Mycologist to the Station at the end of September. Mr. H. R. Briton-Jones, B.Sc., late Mycologist to the Egyptian Government, has been appointed as his successor. At the same time Miss V. G. Scott (Mrs. S. P. Wiltshire) terminated her engagement as Research Assistant at the Campden Experimental Factory and the vacancy on the staff thus created is remaining unfilled pending a decision by the Ministry of Agriculture and Fisheries as to the future grant for Campden.

Arrangements have been made for the transfer of Mr. A. H. Lees from the Advisory to the Research Staff and his place on the former is being taken by Mr. E. Ballard, M.A., late Entomologist to the Madras Government.

Mr. H. W. Miles, B.Sc., concluded his investigations on the life history and control of the Apple Blossom Weevil at the completion of his term as Research Student last July.

A grant for a special investigation on the species of mosses, lichens and algae on the bark of fruit trees, their removal with winter washes and the effect of the latter upon hibernating insects and fungus spores, has been awarded to Mr. S. S. Light, B.Sc., by the Ministry of Agriculture and Fisheries. He will be stationed at Long Ashton during the period covered by it.

Miss Gilchrist, B.Sc., Lecturer in the Botanical Department of the University of Bristol, has continued her investigations on the Myxosporium disease of Apple trees in association with Mr. Wiltshire.

Miss Ridler, attached to the same Department, is collaborating with Mr. Lees in an examination of the physiological anatomy of healthy and reverted Black Currant plants.

At the invitation of the Ministry of Agriculture and Fisheries the Station has agreed to undertake a new branch of work, viz., investigations on Willow growing and the utilization of Willows. Mr. H.P. Hutchinson, B.Sc., late Advisor in plant Pathology attached to the Midland Agricultural College, Kingston, Derby, has been appointed to take charge of this work.

Land and Plantations.—An arable field about 11 acres in extent has been in preparation for the past two years for fruit and new experimental plots will be established there during the present and the following planting season. In addition a further area of about 20 acres of pasture has been taken over from the present tenant of Fenswood Farm and is being drained and ploughed preparatory to fruit culture.

A small grass orchard containing mainly worn-out cider trees has been grubbed and the planting of experimental plots of strawberries, which when complete will occupy about 2 acres, has already been started.

The raising of trees and plants to stock the land referred to is proceeding actively in the nurseries.

In the lowest-lying portion of the farm a field of approximately 4 acres has been appropriated for the establishment of trial plots for varieties of Willows as a part of the Willow Research Scheme.

Buildings.—No new buildings have been erected during the year, but plans have been drafted for various buildings which it is hoped to proceed with during the coming spring. A further reference to these is made in the following section.

General.—A further grant amounting to £5,000 has been promised by the Treasury, on the recommendation of the Development Commission and the Ministry of Agriculture, on condition that the Station provides in addition a sum of £1,750. This is to cover the cost of the development scheme now under consideration, which it is anticipated will cost approximately £6750. Under this scheme the extent of the fruit plantations is to be increased above the 1921 area by 30 acres, a road to serve the land recently developed beyond the railway constructed, farm buildings also required in that connection erected, greenhouses for physiological investigations and other experimental work built, much-needed additions and alterations to the cider buildings and equipment provided, and alterations in the laboratory building to furnish accommodation for recent additions to the Research and Advisory Staffs carried out.

The Ministry has recently sanctioned a small special grant to cover the cost of a survey of soils in the fruit-growing districts of East Anglia and the West of England. This work is being carried on in collaboration by members of the Staffs of the Cambridge University School of Agriculture and this Station.

The Annual Report for 1920 foreshadowed the arrangement of a scheme for closer working co-operation between the East Malling Fruit Research Station and this Station. It is satisfactory to record that a scheme drafted with that object by the Directors of the two Stations has now been approved by the respective Governing Bodies of the Stations and the Ministry.

The year has been marked by a notable increase in the number of visitors to the Station and of enquiries for advice. The holding of the Annual Meetings of the Horticultural Educational Association at the Station resulted in a closer touch being established with those who are engaged in this country in the work of horticultural education, while visits from parties of members of several of the Fruit Growers' and Market Gardeners' Associations in the West of England have strengthened the link with those engaged in commercial horticulture.

It is a pleasant duty to record again the loyal support of the administrative and assistant staffs. Although their work does not come prominently to the notice of those outside the Station, it influences very materially the amount of research which can be undertaken and its efficient prosecution. To these in no small degree the year's achievement has been due.

POT EXPERIMENTS ON THE MANURING OF FRUIT TREES.—II.

By T. Wallace.

During the season of 1922, the experiments with apple trees—Cox Orange Pippin—and strawberry plants—Royal Sovereign—which were commenced in the spring of 1921, were continued, and further experiments on the same lines were commenced on gooseberry bushes—King of Trumps—black currant bushes—Seabrook's Black—and strawberry plants—Leader.

The experiment with strawberry plants—Leader—was discontinued during July as it was evident that many of the pots used were unsatisfactory.

The observations made up to the time of discontinuing the experiment served to confirm those made in 1921 on the Royal Sovereign plants. A further experiment with Royal Sovereign has been commenced this autumn to replace the experiment with Leader.

The following report on the observations made on the apple trees, gooseberry and currant bushes, and strawberry plants, is only to be regarded as a progress report indicating in rather a general way the more important features of the observations which have been made.

The procedure followed during the season was as described in the Annual Report for 1921.

Experiment on Apple Trees.

In general, it may be said that none of the trees in any of the series have made satisfactory growth. This condition may be due in part to the very trying nature of the season—the weather during May was abnormally hot and dry, whilst from June onwards it was generally cold and wet—but it is felt that for the greater part the rigorous conditions to which the trees are exposed may be the chief cause and it is proposed to carry out a few experiments to attempt to improve the conditions of experiment.

Data were obtained during the season on the following points :—

1. Bud break and bud characters.
2. Opening of blossom and blossom counts.

3. Foliage— Coming into leaf.
   Amounts of foliage.
   Leaf types and characters.
   Leaf fall.
4. Condition of barks.
5. Fruit— Set.
   Dropping during season.
   Yields.
   Characters of fruits and their pips.
6. Shoot growth.
7. Root systems.
8. Weight increases.
9. Casualties.

The numbers of fruits obtained from the trees under-going the various treatments were too small to provide material for analytical work and thus only a few characters of these, such as can be determined by observation, taste and smell were noted. Some of the points observed, however, appear to be very significant.

At the end of the season all the original trees of the experiment were living.

The more important results obtained by the different treatments may be summarised as follows :—

Summary of Observations Made.

Series A.—Trees receiving a complete nutrient solution.

The flower buds were plump and developed vigorously after growth commenced in the spring. The foliage was normal in appearance during the early part of the season, but suffered badly from leaf scorch from about the middle of June and by August 12th most of the older foliage had fallen. All the trees were defoliated by November 23rd. No fruit was obtained from these trees as only one tree set two fruits and these dropped during July.

The shoot growth made was better than in any other series.

The root systems were not large but were equal in size to those of any other series. They showed recent growth of both coarse extension roots and fine fibre.

The total increase in weight of the trees of this series is second to those of " omitting calcium " treatment.

Series B.—Trees receiving a complete nutrient solution + sodium sulphate.

The results obtained in this series were similar in practically every respect to those in Series A.

Some fruit was obtained and they showed the characteristic flavour, colour of flesh, etc., of the variety. The pips of the apples were small but plump.

The series comes third for both the length of shoot growth and weight increase made during the season.

Series C.—Nitrogen omitted from the nutrient solution.

The blossom buds were very small and the flowers opened about seven days after those of Series A.

The leaves were small and of a pale yellowish-green colour, and showed reddish tints in the beginning and towards the end of the growing season. Leaf scorch was almost entirely absent from this series.

Defoliation was hastened by this treatment, all the trees being defoliated by October 31st.

There was a heavy set of fruit, the fruits being small and of a vivid scarlet colour, with rather a lack of polish. The flesh was hard. The characteristic aroma of the variety was distinctly lacking from the fruits and a high content of acid and tannin was suggested by their taste.

The barks of the trees were lighter brown in colour than those of Series A.

Shoot development was smaller than in any other series.

The roots were small and practically the whole of the recent growth made consisted of fine fibre.

The series stands sixth for weight increase.

Series D.—Potash omitted from the nutrient solution.

The blossom buds were slightly smaller than in Series A and the flowers were a day or two behind those of the trees in that series in opening.

The leaves were slightly smaller than in Series A and the colour was generally darker than the normal green.

Leaf scorch was present as early as May 2nd and was very severe throughout the season. The trees in Series B were the only others to develop leaf scorch to such an extent as in this series. Practically the whole of the old foliage fell by August, but new tip foliage was retained until November 23rd, on which date the trees were all defoliated.

Six fruits were obtained from the trees of this series and of these four failed to develop and were without pips. The remaining two were not so fully flavoured as those obtained in Series B. and they contained only a few pips of a very dwarfed and malformed character.

The root-systems were very small, being similar in size to those in Series C, and lacked fine fibre.

The series is fifth among the others for both length of shoot growth and for weight increase during the season.

Series E.—Phosphoric Acid omitted from the nutrient solution.

The blossom buds in this series were small, being slightly larger than those in Series C and H, and the flowers were a day or so behind those in Series D in opening.

Only tip foliage was carried during the season, the buds along the shoots failing to break in spring. The leaves were normal in size and did not suffer from leaf scorch so badly as in Series A. The leaves were rather pale green in colour during the early part of the season and by August 26th they had developed a characteristic bronzing.

Defoliation was hastened, all the trees being defoliated by September 4th.

Two fruits were obtained. They were normal in size and appearance, but had rather a "musty" smell and flavour and they did not keep well.

Shoot growth was similar to that made in Series C.

The roots though comparing favourably in size with those in Series D. had made scarcely any new growth and were yellow in colour.

The trees lost in weight during the season.

Series F.—Calcium omitted from the nutrient solution.

The blossom buds were similar to those in Series A and the flowers opened at the same time as those of the latter series.

The foliage throughout the season was plentiful, the leaves being large and their colour fairly normal. The amount of leaf scorch present was similar to that in Series A. During August and September the trees retained more foliage than in any other series and continued to make vigorous shoot growth later than in any series. During the autumn many of the leaves showed brilliant orange coloured tints. The trees were all defoliated on November 23rd.

Although the trees of this series blossomed very heavily there was no set of fruit.

Shoot growth was second to that in Series A.

The root systems were similar in size and character to those in Series A.

The weight increase of the trees in this series was greater than in any other series.

Series G.—Magnesium omitted from the nutrient solution.

The blossom buds were similar in appearance to those in Series D and the flowers opened at the same time as in this latter series.

The amount of foliage was similar to that in Series A. The leaves were of normal size, but were rather pale in colour. During the season some curious colour effects were developed on the leaves, among which were characteristic orange-red tints and brown patches of dead tissue in the centres of many of the leaves. The amount of leaf scorch present was similar to that in Series F.

Defoliation was hastened by this treatment, all the trees being practically defoliated on November 7th.

One fruit set but fell prematurely. Both shoot growth and weight increase in this series came fourth among the series.

The root systems were similar to those in Series A.

Series H.—Trees receiving rain water only.

The blossom buds were similar in size to those in Series C and the flowers opened at the same time as those of this latter series.

The foliage was on the whole rather better than in Series C and the leaves were slightly larger and of a redder tint than in this series. There was no leaf scorch present during the season.

All the trees were defoliated on October 24th, whilst those in Series C were not completely defoliated until October 31st.

The colour of the barks of these trees was brown as in Series C.

The fruits obtained from these trees were larger than from those in Series C but were similar in appearance in other respects.

The flesh of the fruits was very hard and woody and had very little taste. The little flavour present was typically that of the variety.

The pips were very large and plentiful.

Shoot growth was similar to that in Series C, being very poor.

The root systems were the poorest of all the series, the only recent growth being fine fibre. The series was seventh in order of weight increase.

Experiment on Gooseberry Bushes.

The pots used in this experiment are 10in. in diameter and have been treated in a similar manner to those used in the experiment on apple trees.

The bushes were planted on March 9th, 1922, and previous to planting their roots were pruned.

The shoots were pruned after planting.

All the blossom produced during the season was removed to prevent fruiting.

Three bushes per series were lifted on December 20th for root examination.

Data were obtained on the following points :—

1. Foliage;—Coming into leaf
   Amounts of foliage.
   Leaf types and characters.
   Leaf fall.
2. Shoot growth.
3. Buds—Condition of buds at end of season.
4. Root systems.
5. Weight increases.
6. Casualties.
7. Effect of non-leaching of the sand in some of the pots.

Summary of Observations Made.

Three of the items of the above list may be disposed of briefly before going into the various other points which require more detailed treatment, viz.:

(*a*) Coming into leaf.

(*b*) Casualties.

(*c*) Effect of non-leaching of the sand in the pots.

(*a*) Coming into leaf—As all the plants had considerable reserves of food, the time of coming into leaf was in great part independent of the treatments given and thus the differences observed between the plants of the different series were insignificant.

(*b*) There were no casualties during the season.

(*c*) The effect of non-leaching of the sand in the pots produced similar results in all series. Bushes in unleached sand retained their leaves longer than those in leached sand receiving the same nutrient solution. The treatment tended to suppress the development of the natural autumn tints and to replace these latter by a brown marginal leaf scorch. Leaf scorch was developed very severely in all series excepting Series C and H. This latter result is similar to that obtained by non-leaching of strawberry plants in 1921.

Series A.—Bushes receiving a complete nutrient solution.

The foliage was well developed and plentiful. The leaves were large and of a normal green colour. Reddish yellow autumn tints were developed in late September and defoliation took place in November. The bushes were all defoliated on November 23rd.

The shoot growth was very good, being the best of all the series.

The buds formed were plump.

The root systems were excellent, being large and containing plenty of coarse fibre and fine fibre.

The weight increase was largest of all the series.

Series B.—Bushes receiving a complete nutrient solution + sodium sulphate.

The foliage was similar to Series A in amount and colour, though the autumn tints produced were rather more red than in the latter series. All the trees were defoliated on November 23rd.

The amount of shoot growth was fourth and the weight increase was third among the series.

The buds formed were similar to those in Series A.

The root systems were practically identical in size and character to those of Series A.

Series C.—Nitrogen omitted from the nutrient solution.

The amount of foliage was small and there was much bare wood. From the beginning of June, the leaves were small and pale green in colour. Reddish tints were developed about the middle of June and the leaves remained reddish yellow from that time until defoliation took place. Defoliation was hastened, all the bushes being defoliated on October 31st.

Shoot growth was very poor—the series standing seventh—and the shoots were very thin. The buds formed were very small and appeared to be starved.

The root systems were small. They lacked the coarser extension growth and consisted chiefly of fine fibre.

The series was seventh for weight increase.

Series D.—Potash omitted from the nutrient solution.

The amount of foliage throughout the season was plentiful. The leaves were smaller and darker green in colour than in Series A. The earliest autumn tints to develop were yellow and it was not until very late in the season that any red tints appeared.

Marginal leaf scorch was present on many of the bushes during the autumn. The period of defoliation was similar to Series A, all the bushes being defoliated on November 23rd.

The series was fifth for shoot growth, but fourth for weight increase.

The condition of the buds was similar to those in Series A.

The root systems were similar to those in Series A in size but they lacked fine fibre.

Series E.—Phosphoric Acid omitted from the nutrient solution.

The condition of the foliage was similar to that in Series A during the beginning of the season. The leaves were of normal size, but by July 18th many of them were showing marked purple tints. This purpling developed rapidly and was followed by defoliation. Defoliation was hastened. It commenced in early August and was complete by November 7th.

The shoots developed rapidly in length during the early part of the season, but they were very thin.

The series was third in length of shoot growth but only fifth in weight increase. The buds formed were small, but were larger than in Series C and H.

The root systems were similar in size to those in Series F, being much smaller than in Series B. They lacked fine fibre.

Series F.—Calcium omitted from the nutrient solution.

The foliage was generally similar to that in Series A. The leaves were of normal size and colour. They remained green longer than in any other series. Deep red autumn tints were developed. All the bushes were defoliated on November 23rd.

The series was only sixth for both length of shoots made and weight increase.

The buds formed were similar to those in Series A.

The root systems were similar in size and character to those in Series E.

Series G.—Magnesium omitted from the nutrient solution.

The amount of foliage was similar to that in Series A. The leaves were of normal size and became pale green in colour about the middle of July. Towards the end of July they developed broad red bands around their margins, which were characteristic of this series.

Defoliation commenced earlier than in Series A, although the bushes were not completely defoliated until November 23rd.

Shoot growth was second among the series as also was weight increase.

The buds formed were plump and similar to those in Series A.

The root systems were practically identical in size and appearance to those in Series A.

Series H.—Bushes receiving rain water only.

The amount of foliage was small and there was much bare wood.

The leaves were small and early in the season took on a reddish tint. By the middle of July the colour of the leaves was a brilliant red, which colour was retained until defoliation took place. All the bushes were defoliated on October 31st as in Series C.

The buds formed were very small.

The series was eighth for shoot growth and weight increase, the shoots being very thin.

The root systems were similar in size and character to those in series C.

Experiment on Black Currant Bushes.

The pots are 10in. pots prepared as in the experiments on apple trees and gooseberry bushes.

The bushes were planted on March 14th, 1922, and previous to planting their roots were pruned.

The shoots were pruned after planting.

All blossom produced during the season was removed.

Three bushes per series were lifted on December 20th for root examination.

Data were obtained on the following points.

1. Foliage;—Coming into leaf.
   Amounts of foliage.
   Leaf types and characters.
   Leaf fall.
2. Shoot growth.
3. Buds—Condition of buds at end of season.
4. Root systems.
5. Weight increases.
6. Casualties.
7. Effect of non-leaching of the sand in some of the pots.

Summary of Observation Made.

The three items

(*a*) Coming into leaf

(*b*) Casualties

(*c*) Effect of non-leaching of the sand in the pots

may be treated as in the experiment on gooseberry bushes.

Here again the coming into leaf was mainly dependent on the food reserves in the bushes.

There were no casualties during the season.

The results obtained by the non-leaching treatment were similar in character to those obtained by this treatment in the experiment on gooseberries.

Series A.—Bushes receiving a complete nutrient solution.

The foliage was well developed and plentiful. The leaves were of normal size and colour. They developed reddish yellow tints during the beginning of September and about 50% of the leaves had fallen by October 31st; all the bushes were defoliated by November 15th.

The series was third for length of shoots and second for weight increase.

The buds at the end of the season were large and plump.

The root systems were large and there was plenty of both coarse and fibrous material.

Series B.—Bushes receiving a complete nutrient solution + sodium sulphate.

The foliage was similar to that in Series A in amount and in size and colour of the leaves. The autumn tints developed were of a redder shade than in Series A.

Defoliation took place over practically the same period as in Series A. All the bushes were defoliated by November 15th, although on November 7th the bushes were retaining more foliage than in Series A.

The series was only fifth both for length of shoots and weight increase.

The condition of the buds and the size and appearance of the root systems were similar to Series A.

Series C.—Nitrogen omitted from the nutrient solution.

The foliage in this series was very thin and there was much bare wood on all the bushes. The leaves were small and yellowish green in colour. Red tints were developed about July 28th and these became very pronounced during August. Defoliation was hastened by this treatment. The foliage was very thin on September 25th, and all the bushes were practically defoliated on October 31st.

The series was eighth for both shoot growth and weight increase. The shoots were very thin.

The buds were very small and starved looking.

The root systems were small and similar in size to those in Series H. They were dark brown in colour and the only recent growth to be seen was of fine fibre.

Series D.—Potash omitted from the nutrient solution.

The foliage during the early part of the season was fairly thin and there was a fair amount of bare wood. The leaves were smaller and of a darker green colour than in Series A.

The tints developed in autumn were almost entirely yellow in colour and most of the leaves at this period showed a tendency to curl back towards their under surfaces and to develop leaf scorch. Defoliation took place as in Series B.

The series was sixth for shoot growth and fourth for weight increase.

The buds looked even more plump than in Series A and the root systems were similar in size and character to those of that series.

Series E.—Phosphoric Acid omitted from the nutrient solution.

The amount of foliage and size and appearance of the leaves were as in Series A until the end of July when the leaves developed a brownish purple tint. This tinting developed rapidly during August and purple coloured spots were observed on the leaves from September 4th. The older leaves began to fall about the end of August and by October 10th the foliage was very thin. All the bushes were practically defoliated on October 31st.

The series was fourth in length of shoot growth but the shoots made were very thin, whilst for weight increase the series was only sixth.

The buds formed were small, being larger than in Series C and H, but much behind those of the other series.

The root systems were slightly larger than in Series C and H, but much behind those of Series A, etc.

Series F.—Calcium omitted from the nutrient solution.

The foliage was normal in amount and the leaves were similar to those in Series A in size and colour. The tints developed in Autumn were of a very deep red colour, though not so deep as in Series G.

All the bushes were defoliated on November 15th as in Series A, but during the last few days of October the foliage of the plants was much fresher than in any other series.

The series was second for length of shoots and third for weight increase.

The buds were very plump, being similar to those in Series D.

The root systems were similar to those in Series A.

Series G.—Magnesium omitted from the nutrient solution.

The amount of foliage was normal. The leaves were similar in size to those of Series A, but the colour was not good, being paler than normal from the beginning of July. During the beginning of August the leaves developed red tints and by the third week in September these tints had changed to deep purple, which colour was quite characteristic for the series. The leaves after developing the purple tints showed much curling towards their under surfaces, the curling being more pronounced than in Series D.

All the bushes were defoliated on November 15th, the period of of defoliation being practically identical with that of Series A.

The series was first for both shoot growth and weight increase.

The buds were very plump, being similar to those in Series D.

The root systems were as in Series A.

Series H.—Bushes receiving rain water only.

The amount of foliage was small, being similar in amount to that in Series C. There was much bare wood from the beginning of the season. The leaves were small and pale green in colour. They soon developed reddish-yellow tints and by July 1st they showed much reddening. The tints were redder than in Series C. Some of the leaves began to full in early August and by September 25th the foliage was very thin. Defoliation was hastened, all the bushes being defoliated on October 31st.

The series was seventh for both shoot growth and weight increase. The shoots were very thin and the buds were very small.

The root systems were small and similar to those in Series C, showing growth of fibre but lack of coarse material. They were dark brown in colour.

Experiment on Strawberry Plants—Royal Sovereign.

During 1922 the plants in this experiment did not make very vigorous growth. They suffered rather severely from an aphis attack during the early part of the season and from the hot dry weather in May and early June.

All the four plants of Series X, which had survived the non-leaching treatment during 1921, failed to start into growth in the spring.

Data were obtained during the season on the following points :—

1. Nature of spring growth.
2. Opening of blossom.

3. Growth of plants.
4. Foliage—Leaf size and characters.
   Autumn changes.
5. Fruit—Crop weights.
6. Casualties.

The only data on the fruits presented below are those on the order of the total weights per series.

Summary of Observations.

Series A.—Plants receiving a complete nutrient solution.

The plants made vigorous growth in the early spring. The first flower was open on April 22nd. The growth made in this series was better than in any other. The leaf stalks stood erect and the leaves were well developed and of a healthy green colour. The first autumn tints were observed on September 25th. They were red and as the season advanced the chief colours developed were red and yellow. In late autumn the plants appeared fresher than in any other series.

The weight of fruit borne by these plants was much greater than in any series.

All the original plants of the series are living.

Series B.—Plants receiving a complete nutrient solution + sodium sulphate.

The early spring growth was similar to that in Series A. The first flower was open on April 22nd as in Series A.

The growth of the plants throughout the season was similar to that in Series A though the plants were rather smaller. The size and colour of the leaves were normal.

Autumn tints were first observed on September 25th. The chief colour developed was red and the tints in this series were on the whole redder than in Series A.

The foliage remained almost as fresh as in Series A during the latter part of the season.

The series was only third for yield of fruit.

Two of the original plants have died.

Series C.—Nitrogen omitted from the nutrient solution.

The growth made in the early spring was very weak. The first flower was observed to be open on May 13th—21 days after the first in Series A.

The plants of this series made the poorest growth of any series throughout the season and remained in a dwarfed and obviously weak condition.

The leaves were very small and pale green in colour and as early as May 13th they developed red tints. The tints were very vivid in the autumn and by November 15th practically all the foliage had died down.

The series was seventh in order of fruiting.

Five plants have died in this series, which number is greater than in any other.

Series D.—Potash omitted from the nutrient solution.

The early spring growth was similar to that in Series A, but growth began to fall behind after May 3rd.

The first observation made of a flower being open was on May 3rd, on which date four flowers were open.

The plants in this series fell greatly behind Series A from the beginning of June. The leaves after this date were small and dark green in colour, whilst the leaf stalks were shorter and thinner than in Series A.

Autumn tints were first observed towards the end of September. The colours developed in this series were generally dull. The most prominent colour was yellow and there was a large amount of brown edge scorch present during the autumn. Occasionally a few red and purple tints were observed.

The series was fourth for weight of fruit produced.

One plant has died.

Series E.—Phosphoric Acid omitted from the nutrient solution.

In early spring the growth was only a little ahead of that in Series C and H. The first flower was observed to be open on May 3rd.

The growth during the season was poor, being well behind that in all the series excepting C and H. There was a tendency for the plants in this series to have only single crowns. The leaves were relatively few in number but were fairly normal in size. The colour of the leaves throughout the season showed signs of the plants being unhealthy. Purple tints were developed as early as June 12th and this purple colour of the foliage was characteristic for the series. The purpling was very marked during the autumn. By November 15th most of the foliage had died down.

The series was sixth for fruiting.

Four plants have died.

Series F.—Calcium omitted from the nutrient solution.

The plants were a little behind those in Series A, B and D for spring growth.

The first flower was observed to be open on April 22nd as in Series A, but by May 3rd no further flowers were open.

Growth throughout the season was similar to that in Series B and occasionally the plants carried some very large leaves on long though rather thin leaf stalks.

The leaves were generally similar to those in Series A in size and colour.

Autumn tints of a red colour were first observed on September 18th. Later in the season bright red, yellow and orange colours were developed.

The series was only fifth in order of fruiting.

Two plants have died.

Series G.—Magnesium omitted from the nutrient solution.

The early spring growth made by the plants was similar to that in Series F.

The first flower was open on April 22nd as in Series A.

The growth made during the first half of the season was just a little behind that in Series F, but during the second half the condition of the plants was very poor. The plants lost their upright habit and lay very flat, whilst many of the leaf stalks appeared to be much shorter than normal.

The leaves developed during the early part of the season were normal in size, but during the latter part those produced were often small. The colour of the leaves throughout the season was generally abnormal, sometimes being pale green in colour or exhibiting a mottled effect by developing patches of pale green, whilst occasionally deep purple tints were developed.

Autumn tints were first observed to be developing on September 25th. The earlier tints were purple and later were mostly red or yellow and not of a very brilliant character. In late October some of the tints were developed in patches as on the leaves of the apple trees receiving no magnesium, and as broad bands as on the leaves of the gooseberry bushes undergoing similar treatment.

The series was second for amount of fruit.

Two plants have died.

Series H.—Plants receiving rain water only.

The growth made in the early spring was very weak, the series resembling Series C.

The first flower was open on May 13th as in Series C.

The growth throughout the season was very poor, though the plants always appeared to be slightly better than those in Series C.

The leaves were small and pale green in colour and by May 13th they were showing red tints. The foliage after this date was mostly red, the colour being brighter than in any other series.

Most of the foliage had died down by November 15th.

The series was eighth in order of fruiting.

Only one plant has died from this treatment.

FACTORS GOVERNING FRUIT-BUD FORMATION.—V.

By F. Summers.

Further Experiments upon the Ringing and Notching of Fruit Trees.

The following experiments were carried out during the growing season of 1922 in order to supplement the work of Barker and Lees upon the above subject, which is described in the numbers of this Report for 1916, 1919 and 1920.

The trees employed were wall-trained trees of pear and plum and stock types of apple, pear and cherry. All rings were made upon shoots of the previous season's growth and were about 1.5 mm. in width. The various operations described below were carried out on March 15th and 16th.

Attention was chiefly directed towards the possibility of isolating any stimulus due to actual wounding. It was further suspected that often rings which were made close up to the bud—especially on the lower side—often caused injury to the vascular system supplying the bud which thereupon became incapable of further development.

Below will be found in appropriate sections an account of the various operations and their results.

I.—Ring close to the top of the bud.

Here the ring was made as far down in the angle subtended by the bud as was possible without causing injury or disturbance to the bud itself.

(*a*) *Pruned Shoots of Cherry.*

In these the top four buds were pruned away leaving about 5 mm. of wood above the 5th bud which now became the terminal. The ring was then placed above the fourth bud below this. At the end of a month all the buds, except the basal four, had begun to break and there was a decided difference between those above and below the ring. The four buds next below were well developed with

normal reddish leaves. Those above the ring were less developed, with smaller leaves from which the red pigment was completely absent. In some of the shoots these leaves became badly scorched and were on that account left out of consideration. Shoots which were similarly pruned but unringed showed an ordinary acropetal bud break with the terminal the largest.

At the ends of two months, in the ringed shoots, the buds above the ring began to make up leeway and, at the same time, both the ring and the pruning cut showed signs of having healed. At the end of another week these buds had gone so far ahead as to give the shoot an appearance similar to that of an unringed pruned shoot, the terminal being now slightly the best.

In this case, although the possibility of a wound-stimulus to the bud immediately below the ring cannot be excluded, it appears as though the phenomena described were due, primarily at least, to interference with the water supply to the portion of the shoot above the ring coupled with excessive loss of water by evaporation from the cut end.

(*b*) *Pruned Shoots of Apple and Pear.*

An almost similar state of things to the above was found in similarly treated shoots of apple and pear, but the colour effect in the leaves was absent and the three distal buds began to overtake those below the ring about three weeks earlier. At the end of nine weeks the terminal bud was decidedly the best and the scars were completely healed. In shoots which were pruned but unringed the terminal went ahead from the start except in cases where the cut was made too close to the upper side of the bud when this suffered an initial check.

(*c*) *Unpruned Shoots of Pear.*

In these shoots the ring was placed above the fifth bud from the terminal. Bud break commenced forty days from the start, the one next below the ring being slightly ahead. At the end of a further period of fourteen days, however, the terminal had begun to outstrip the former and this relative rate of progress was then maintained for the rest of the growing period.

As in the pruned shoots of apple and pear, ringing in the distal portion of the shoot had no effect whatsoever upon the three or four small buds at the extreme base; these remained dormant throughout.

From the foregoing it appears that the retarding effect due to the pruning cut was relatively greater than that due to the ring, but that when the two were combined the first effect was greatly magnified and, in consequence, the buds above the ring recovered their dominance much less rapidly.

(*d*) *Unpruned Shoots of Plums.*

The rings were made in this case not only in the upper portion, but also in the middle and near to the base of the shoot, viz., above the 13th and 28th buds from the apex.

In the basal region no effect whatever was produced so far as could be observed, although a pruning cut above a similarly situated bud would cause it to grow out strongly. In the more distal portion there was no more pronounced an effect than a very slight retardation of the bud above the ring or an acceleration of that below the ring according as the effect is viewed. It may be that normal bud break in this plum was so strong as to mask any effect due to ringing in the upper portion, but in only one case was the ring found to increase the relative development of buds below the ring and so disturb the normal acropetal order of development.

II.—Ring close to the Base of a Bud.

It was found that ringing to the wood below a bud was generally fatal to its development when the ring was placed nearer than 5 mm. to the leaf scar. The rings were therefore placed 8-10 mm. below the fourth bud from the pruned end of the shoot.

(*a*) *Pruned Shoots of Cherry.*

The course of events here was almost precisely the same as that described in I (*a*) above with this exception; the bud immediately above the ring did not recover from its initial check but remained the smallest throughout. In other cases the bud immediately below the ring reached a stage of development slightly greater even than that of the terminal.

(*b*) *Pruned Shoots of Apple and Pear.*

Here a similar state of things was found in respect to the results described under I (*b*). The bud immediately above the ring made very little progress in any case, while often the bud next below reached a stage of development at least equal to that of the sub-terminal.

(*c*) *Unpruned Shoots of Pear.*

No retarding effect was found here above the ring during the first month. In some cases where the bud above the ring appeared to be retarded at the commencement of bud break this effect was quickly eliminated and an acropetal order of development brought about. The terminal bud retained its dominance throughout and again the most basally situated buds failed to made any growth.

(*d*) *Unpruned Shoots of Plum.*

The bud immediately above the ring was, in most cases, definitely retarded and, although a good deal of recovery was made during

the second month, it generally remained at least slightly below normal. The question still needs investigation as to how far there is a greater risk of injury by ringing to the bud of the plum than to that of the apple or pear and these experiments will be repeated in combination with histological examination of the treated shoots.

III.—Ring midway between two Buds.

In these experiments it was expected that any stimulus to growth, due to wounding, would affect similarly the two buds immediately above and below the ring.

(*a*) *Pruned Shoots of Cherry.*

These shoots were pruned as in I (*a*) and II (*a*) before being ringed. Contrary to the results in these two cases, the two buds next below the ring showed maximum development throughout in spite of the large amount of recovery from the initial check made by the buds above the ring. That immediately above the ring was persistently smaller than the two on each side of it.

(*b*) *Pruned Shoots of Apple and Pear.*

The results obtained here agreed with those described under I (*a*) except in those cases where the ring was placed in the basal or lower middle portion, when there was no perceptible effect due to ringing.

(*c*) *and* (*d*) *Unpruned Shoots of Pear and Plum.*

No definite results were obtained when shoots of this kind were ringed in their upper or middle portions. Negative results always followed similar treatment of the basal portion.

IV.—The Effect of Longitudinal Slits.

In further experiments on the wound effect slits of the same width as the rings employed above were cut down the shoots from immediately below the base of one bud to the top of the next but one below. Slits of this kind were made in the upper third of some shoots and in the middle and lower thirds of others. Although numerous shoots were treated in this manner only two cases of exceptional bud growth in the region of the cut were observed and these both occurred in unpruned shoots of pear. In each case the bud below the slit produced a slightly better developed shoot than any but the terminal and sub-terminal.

On the whole, however, the results of these experiments are best regarded as negative.

V.—The Annular Notching of Buds.

In this operation a ring of the usual width was placed round an individual bud at a distance of 5 mm. from it as centre. A small but distinct effect was the result in unpruned shoots of plum and in pruned shoots of pear and apple. The effect was not noticeable in buds of the upper and middle portions of the shoot owing to its transience. In the lower portion the buds near to the base could be brought to the point of breaking by ringing in this way, but only in the case of the plum was there sufficient further progress to produce a tiny shoot. It should be remarked that the buds of this plum were to the eye comparatively stronger than the correspondingly situated buds of the pear and apple, so that it is probable that there is a varietal difference involved here. In any case the response should be regarded as a pure wound effect; the bud can be stimulated to begin growth but the conditions for further development are evidently absent.

VI.—Conclusions.

While the foregoing observations are far from complete they possess a certain amount of interest when considered together.

Apparently a definite wound stimulus does come into action when a shoot is notched or ringed in the neighbourhood of a growing point. (This wound stimulus has of course nothing to do with the effect of a mechancal injury such as severing the channels of water supply to the bud). The stimulus is slight and is probably manifested through the increased respiration of the growing point causing the beginnings of growth in the bud. It is too small to be apparent in normal quickly-growing buds, where it is masked, and the subsequent growth of a bud so stimulated depends on some other factor.

A ring definitely modifies the water supply system of the shoot to the disadvantage of the bud next above the ring. If a vigorous terminal bud is present the severity of this is mitigated so far as the former bud is concerned as though the terminal had the capacity for uplifting adequate supplies of water past the break in the conducting system. When the terminal is absent, or is replaced by a source of water loss, *e.g.*, a pruning cut, the severity of the modification is increased and until the surfaces of the ring and cut are healed the buds above the ring suffer from an inadequate water and food supply.

The precise manner in which the water supply is modified is being investigated and will be discussed in a future report.

FACTORS GOVERNING FRUIT-BUD FORMATION.—VI.

By F. Summers.

The Stimulation of Bud Growth in Cuttings by Inorganic and Organic Solutions.

In 1918 the American worker, Curtis, published the results of an extensive series of researches on the stimulation of root-growth in cuttings by treatment with chemical compounds. The greater portion of this work was carried out upon cuttings of the Privet (*Ligustrum ovalifolium*), but cuttings of species of Prunus, Populus, Kerria and Forsythia were also employed.

The solution investigated chiefly as a stimulant was potassium permanganate ($KMn\ O_4$), but solutions of other manganese salts were also tried in addition to those of salts of iron, calcium and boron. In a second part of the investigation solutions of saccharose, glucose, peptone, asparagin and other organic substances were employed.

The cuttings were apparently immersed for a certain length of time in a bath of the particular solution under trial and, after being washed free from the chemical, were grown on either in distilled water or moist sand.

Although the author's attention was primarily directed to the stimulation of root formation certain effects upon the top growth of the cuttings were observed which are of interest as bearing on the problem of bud stimulation.

Curtis found that if unripe succulent cuttings of Ligustrum, gathered on August 30th, were allowed to stand for three days in solutions of 1 to 10 per cent. of cane sugar and then were brought into distilled water the resulting root-growth was markedly increased, the greatest increase being shown by the cuttings which had been treated with the strongest sugar solution. Not only was the sugar absorbed, but it was converted into starch and stored in the cuttings in that form. Such immature twigs could, if stood in the sugar solution for two days, store sufficient starch to permit of top growth being started in addition to growth of the roots.

Although the cuttings died if left continuously in sugar solutions, mature cuttings brought into distilled water after treatment for 2 to 15 days showed increased top growth of a peculiar character. This consisted of a maximum development of shoots from the 2nd to 4th internodes from the top coupled with partial or total inhibition of growth from the buds of the uppermost nodes. Even when darkened these buds developed although the uppermost ones had at the same time been exposed to light.

Curtis advanced two alternative explanations of this disturbance of order of development. On the other hand he considered that the sugar might increase the concentration and osmotic pressure in the cells of the lower part of the cutting and thus withdraw water from the upper part; on the other hand he considered that an increased supply of organic matter might be made available for the lower buds which, in consequence, would be able to grow out earlier and more strongly than the upper buds. As evidence supporting the first of these, he described how, in practically all cases, the upper part of the shoot became withered after the shoots below were formed.

Curtis also tried the forcible injection of cuttings of privet and tomato with sugar solutions and in this way increased greatly their sugar content. He found that the bud development of Ligustrum was thereby distinctly retarded irrespective of the solution injected. Cuttings which had been under the suction pump started growth 40 days after being set out, while untreated shoots started in 10 days.

The present writer started a series of experiments with injected apple cuttings in April, 1921. The sugars employed were saccharose, dextrose and levulose in strengths of 0.5 per cent. Other twigs were injected with diastase (5 per cent.) or tap water.

The cuttings were as uniform in size and appearance as it was possible to select and possessed 11-14 buds each. They were placed in batches of five, with their ends in a small beaker containing the liquid to be injected and then brought into a container which could be almost completely exhausted by means of a filter pump. The vacuum in the container was then gradually lowered when the gases in the spaces of the cutting quickly rushed out from the cut end. The original pressure was then gradually restored and the solution allowed to penetrate into the twigs. These were then rinsed and placed with their lower ends in tap water.

Preliminary experiments, in which a 1 per cent. solution of watery eosin was employed, were carried out in order to gain some idea of the distance to which an aqueous solution could penetrate under the conditions of experiment. In one such test an apple shoot, 26cm. in length and having 13 buds, was injected as described above with eosin and subsequently sectioned. The stain could be

traced definitely in the wood for a distance of 20 cm. For the first 15 cm. of this the stain was deep in both the outer and inner layers of the wood. For the next 3 cm. it was quite decided in the outer layers, but fainter in the inner, while in the succeeding 2 cm. it was only possible to trace it faintly in the outer layers.

The penetration into the vascular strands of the individual buds was not altogether what would be expected to correspond with this gradient. It was very marked in the case of the three basal buds, but there was no penetration at all to the three next above. Penetration to the 7th and 8th from the base was good but not in the uppermost four. Where penetration was good the stain could be seen collected densely in the growing point itself. If, therefore, the action of an injected fluid is strongly localised the possibilities of irregular penetration must be considered.

There was no sign of a retardation of bud-break consequent upon injection such as that described by Curtis for Ligustrum and which he ascribed to an additional rest period induced by filling the air spaces of the cutting with fluid. But, as observed by Curtis, in the case of cuttings he treated with saccharose, there was a tendency for those injected with dextrose or levulose to show the strongest bud development in the internodes below the terminal three. In the cuttings treated with saccharose, however, the terminal buds invariably grew out most strongly.

During the first forty days the buds of all the injected cuttings, including those injected with water, were always more advanced than those of the non-injected controls. In all cases there was the tendency for the buds at the base, *i.e.*, nearest the water, to show the first signs of breaking.

At the end of three weeks there was not much difference in point of development between the sugar-injected cuttings and those injected with water. During the next ten days the buds of the former went decidedly ahead, saccharose apparently being, on the whole, superior to either dextrose or levulose as a stimulant. Diastase was uncertain and irregular in action, which behaviour was probably connected with incomplete penetration owing to the colloidal nature of the solution.

If the cuttings were given a second injection a week after the first the stimulating effect was increased, especially in the case of levulose.

A parallel series of experiments was carried out in which the cuttings, after injection with sugar, were ringed to a width of one centimetre in the fourth internode from the base. The result was the same in every case ; the buds below the ring grew out normally but, before any growth could be made by those above the ring, the portion of the shoot there became shrunken and dessicated. The atmosphere of the room was very dry and, in all probability,

the evaporation from the surface of the ring was so severe as to withdraw water from the shoot above it and, at the same time, interrupt the upward flowing water current. The existence of such an effect has been shown by potometer experiments to be described elsewhere.

When the results above are considered, together with those of Curtis, the following conclusions can be drawn.

(1) Bud growth may be both accelerated and increased by injection of cuttings with solutions of sugars or diastase in suitable strengths.

(2) Irregularities of bud break, *i.e.*, so-called disturbances of polarity, may be due wholly or in part to irregularities of penetration on the part of the injected fluid.

(3) Bud break is dependent on the continuity of the water column in the shoot being maintained. The osmotic concentration of the sap alone is insufficient for this purpose in the face of severe competition, *e.g.*, evaporation from the wound surface in ringed shoots.

The third conclusion above applies only to shoots in the earliest stages of bud break. As the development of shoots proceeds these become able to maintain a continuous water supply even when evaporation is severe.

No stimulating effect was found when cuttings were injected with potassium permanganate in 0.5 p.c. solution, nor were two successive injections more successful in this respect. Phosphoric acid in 0.05 p.c. solution appeared to have a slight but definite stimulating effect upon the terminal buds which soon out-stripped the corresponding buds of the controls and at the end of forty days were better even than those of the levulose or diastase-injected cuttings.

Injection of Attached Shoots with Diastase.

The experiments to be described below were carried out on shoots of the previous year's growth of two pot trees of Brayton Hall and Woolf River.

In one case, which may serve as an example, the shoot was furnished with 34 buds. On April 19th the first 28 buds from the apex were on the point of breaking. The remainder showed no signs as yet, but only No. 34 appeared to be definitely dormant. By means of a hypodermic syringe a 1 p.c. solution of diastase was injected into punctures made on each side of the bases of buds 18, 26 and 31, the punctures being made to the level of the lowest part of the growing point in each case. Two further injections, this time with 5 p.c. diastase, were made at intervals of one week from the start. Control shoots were merely punctured and inoculated with water.

Although there was no great response in the case of bud 26, the other two went ahead from the start. By the sixth day 18 was much

better than the terminal, while 31 was the fourth bud, in descending order of magnitude, buds 32 and 34 were still dormant.

This relative rate of progress was maintained throughout the growing season until finally 18 and 31 had each produced an extension shoot, while no other bud had done more than give rise to a short spur. The extension shoots were certainly spindly in form and, although they began to grow out normally in the spring of the following year, most of the leaves produced by both terminal and lateral buds became infected with mildew (*Podosphaera leucotricha*), while the rest of the tree was free.

The control shoots showed none of this increased growth which must therefore be ascribed to the agency of the diastase. The action of this enzyme upon the reserve carbohydrates of the tissues in the neighbourhood of the growing point leads, in all probability, to the provision of a greatly increased store of soluble products which enable the bud in the early part of the season to gain an advantage over those on each side. As the early stages of development proceed and the leaves of the shoot begin to develop a transpiration current to it this concentration gradient becomes flattened out and finally reversed when soluble carbohydrate material is transferred back to the shoot from the leaves. By this time, however, buds which have meanwhile made little or no growth are definitely too backward to produce more than a dwarf shoot.

According to this view, not only the quantity of reserve carbohydrate near the growing point is decisive of the performance of the bud, but also the rate at which this is made available by enzyme action during the early stages of growth.

The interest of the above observations lies chiefly in their clear indication of the possibility of stimulating the buds of any portion of the shoot to increased quantity of development by appropriate methods and agents. It remains to be investigated whether this is merely a function of the quantity of available food reserves or whether there exists an additional " bud factor " which precludes the fullest development as in the case of the spindly diastase-injected shoots.

RASPBERRY NOMENCLATURE.

By N. H. Grubb* and G. S. Peren.

This subject has been approached by the Research Stations of East Malling and Long Ashton in co-operation. The following article constitutes a preliminary report on their joint work and indicates the preparatory systematic examination of stocks of varieties necessary before experimental work with this fruit can be begun on a sound basis.

The material forming the collection of varieties of raspberries at East Malling was obtained mainly from market growers, while that at Long Ashton was mainly from nurserymen and included many samples of the same variety from different sources. At the same time many well-known raspberry districts were visited from East Malling and notes made regarding the varieties grown and names used. Both Stations have concentrated on the summer red-fruited varieties as being of chief commercial importance.

Since all commercially important British varieties are included in the combined collection, the following joint summary of the relation between varieties and names gives a fairly accurate view of the existing confusion in regard to nomenclature.

Table I shows the number of distinct varieties found to be grown under the various names: it is considered here that any variety constituting 50 per cent. or more of the plants in a plantation may be regarded as grown under the name above.

TABLE I.

Number of Varieties Grown Under Each Name.

Number of Varieties.	*Name given.*
2	Antwerp, Black
8	Antwerp, Red
8	Baumforth's Seedling
3	Carter's Prolific
4	Fastolf
7	Fillbasket
7	Hornet
2	Laxton's Bountiful
3	Norwich Wonder
2	Profusion
2	Pyne's Royal
3	Semper Fidelis
5	Superlative

* Of the East Malling Fruit Research Station.

Under other names, only one variety was found for each ; the most important of these are Bath's Perfection, Devon and Mitchell's Seedling.

It should be noted that still other varieties were often found growing under several of these names ; but being under 50 per cent., were considered as " rogues." In some cases it would be impossible to state the true number of these " rogues "—such varieties as Hornet (A) and Superlative having frequently very many kinds of " rogues " mixed with them.

Whilst all the thirteen names given in Table I were applied to more than one variety, in many cases the same variety was found to occur under more than one name. Here again varieties constituting 50 per cent. or more of the plants in a plantation are regarded as grown under the names given.

TABLE II.

VARIETIES GROWN UNDER MORE THAN ONE NAME.

(The varietal names here given are those given in " Commercial Varieties of Raspberries at East Malling," Vol. III, No. 1 of the *Journal of Pomology*).

Variety.	*Names given.*
Bath's Perfection ..	Bath's Perfection, Superlative, Baumforth's Seedling, Hornet, Red Antwerp, Abundance, Marlborough (from U.S.A.). (Of these names Abundance and Marlborough are recognised synonyms for Bath's Perfection).
Baumforth's Seedling B	Baumforth's Seedling, Hornet, Semper Fidelis, Fillbasket, Red Antwerp, Fastolf, Superlative.
Hornet A.	Hornet, Baumforth's Seedling, Norwich Wonder, Superlative.
Red Antwerp B ..	Red Antwerp, Carter's Prolific, Norwich Wonder.
Norwich Wonder ..	Norwich Wonder, Fillbasket, Laxton or " Laxton's Fillbasket."
Black Antwerp A ..	Black Antwerp, Red Antwerp, Late Antwerp.
Red Antwerp A ..	Red Antwerp, Black Antwerp, Early Antwerp.
Red Antwerp F ..	Red Antwerp, Black Antwerp.
Baumforth's Seedling C	Baumforth's Seedling, Hornet.
Hornet B	Hornet, Fastolf.
Mitchell's Seedling ..	Mitchell's Seedling, Profusion.
Red Cross	Red Cross, Royal.
Pyne's Royal ..	Royal, Red Cross.
Superlative	Superlative, Devon.

Some of these varieties also occurred as " rogues " (less than 50% of the plants), under still other names. In some cases no one variety constituted as much as 50% of the plants ; and in one case ten plants were found to include at least four and possibly five varieties.

We thus find that even where a certain name (*e.g.*, " Bath's Perfection "), is applied to only one type, the same varieties may actually be grown under several other names ; it seems that nearly

all growers of raspberries know what to look for under the name Bath's Perfection, but that they fail to recognise the same variety under another name.

The presence of "rogues" in many samples has already been mentioned. The newer varieties are, of course, usually free from "rogues," though even these are sometimes found to include a small percentage of other varieties. Bath's Perfection in particular, is rarely sent out, even under another name, with any appreciable proportion of "rogues"; the variety (Bath's Perfection) does sometimes occur as a "rogue" amongst others, but even this is uncommon. Of twenty-one samples received at the two Stations as Bath's Perfection every one was true to name and free from "rogues." Of other varieties received, from ten or more sources, Superlative was the only one of which as many as 50 per cent. of the samples were true to names and free from "rogues."

From the foregoing data it can be seen that the nomenclature of raspberries is in a state of considerable confusion. Several of the factors responsible may here be mentioned.

Firstly, the growth of seedlings from the seeds of fallen fruits is undoubtedly responsible for the presence of "rogues" in many varieties.

Secondly, where a variety normally produces few canes, the growth with it of "rogues," which normally produce many canes, will naturally tend to suppress the true variety and it is to be expected that any of them which happen to have a commercial value may be propagated and disseminated under the name of the variety among which they occur.

Thirdly, the careless transference of a name from one variety to another with the dissemination of the wrong variety under the name is undoubtedly another large factor.

Yet another possible cause of the confusion, which many growers believe to be very common, is the production of new forms through "bud sporting" from the roots. Although one or two possible examples of this have been seen at East Malling, we have not yet discovered a case where it has been sufficiently widespread to cause confusion.

Conclusion.

The nomenclature of raspberries is in a state of considerable confusion and the greatest possible care should be taken, when obtaining canes for planting, to make sure that the variety is actually the one desired and that it is not mixed with a large proportion of "rogues."

WOUND DRESSINGS.

By S. P. Wiltshire.

In view of the serious nature of those diseases which can enter trees through pruning wounds (more particularly canker and silver leaf) it is obviously of first importance to have a really good dressing which will protect wounds from attacks by parasitic fungi. There are of course a number of preparations in common use at the present day, but astonishingly little accurate work has been done as to the efficacy of these substances. A programme of work, therefore, was drawn up to test some of the well-known substances together with a number of laboratory preparations which appeared to promise good results or might yield information as to the healing of wounds which would be of value in the investigation.

So far only a preliminary trial has been carried out and the results cannot therefore be regarded as other than tentative. As such, however, they may not be without interest.

The first part of the programme was confined solely to the testing of various dressings on wounds. Up to the present time the following commonly used substances have been tried :—gas tar, white lead paint, clay and cow dung, Stockholm tar, grafting wax, a proprietary grafting compound, and the following experimental substances, anti-fouling paint, surgical tape, gum arabic solution with a disinfectant added, creosote (lysol), flexible collodion, boiled linseed oil and chalk, glycerine jelly with a disinfectant, and india rubber solution. The substances were tried on wounds made on the trees in the course of the winter pruning and, except in the case of a small number of trials made at the beginning, were applied immediately after the wound was made. Observations have been confined chiefly to the nature and rate of callus formation, the weathering of the applied dressing, and the ease of application, the experiment not having extended long enough to permit any observations being made as to the protection against fungi afforded by the various preparations.

Comparatively speaking only a few of the substances tried weathered at all well. Clay and cow dung, Stockholm tar, gas tar, the grafting compound, boiled linseed oil and chalk, all weathered more or less badly, and in the case of a number of others

there was no trace of the dressing remaining after four months, although in a number of these the substance was absorbed and could therefore not be seen. Anti-fouling paint weathered extremely well and only showed any sign of cracking when the callus began to form beneath it. White lead paint was good also. A number of these substances caused a killing back of the tissue of the wounds, notably lysol, gas tar and gum arabic. On the other hand surgical tape and, to a lesser extent, grafting wax and clay and cow dung, encouraged callus formation greatly. The former substance was bound round the branch and kept the surface of the wound moist, weathering much better than clay and cow dung, which otherwise would probably have given just as good results. The general indication afforded by the results to date appears to be that those dressings which aim at producing a disinfecting and protective action retard healing somewhat, whilst those which aim at simply keeping the cut surface moist encourage it.

Another point which was dealt with in these preliminary experiments was whether the time of year had any influence on the rate of healing. For this purpose, dressings were applied in late winter (10th February, 1922), at bud break (29th April, 1922), and at midsummer (26th July, 1922), Stockholm tar, white lead paint, clay and cow dung, and grafting wax being used on different trees. On June 8th the wounds made on April 29th were found to be much further advanced in healing than those made on February 10th, a somewhat astonishing result.

Various types of cuts were also made to see if the type of wound had any influence on the rate of healing. No noticeable differences were observed, however, although in the case of a piece of cortex 1in. square was removed, the top and the sides of the square healed much more rapidly than the bottom.

To achieve the object of this programme will probably be a long and tedious process, the large number of treatments which have to be made necessitating very considerable labour. Whether a dressing which gives a good covering, which does not crack, or severely kill back tissues around the wound is to be desired in all cases is doubtful, but for general purposes it is probably best, whilst for grafting purposes one which encourages rapid callus formation is to be preferred.

TRIAL CIDER AND PERRY ORCHARDS.

By O. Grove and T. Wallace.

During the autumn of 1921 the Trial Cider Orchards in Worcestershire and Herefordshire were visited, but as it was not possible to complete the analyses of the soil samples taken from the orchards before the publication of the Annual Report of that year, it was decided to hold back the whole of the report on the tour until the soil data were available.

The report on the trees in all of the Trial Orchards in the two Counties, together with the soil data from these and remarks on their management, etc., are given below.

This report concludes the present series on the Trial Orchards planted between 1908-1910, the former reports of the series on those situated in Devon, Gloucester and Somerset having appeared in the Annual Report for 1919 and on those in Monmouth in the Annual Reports for 1919 and 1920.

Worcestershire.

Madresfield Court, Malvern.—Geological Formation, New Red Sandstone, Keuper Marl.

This orchard was planted in 1908 with two trees of each of the following varieties of cider-apples: Cap of Liberty, Foxwhelp, Cherry Pearmain, Cowarne Red, Dymock Red, Fair Maid of Devon, Neverblight, Skyrmes Kernel, Broadleaf Norman, Court Royal, Improved Pound, Sweet Alford, Sweet Coppin, Cherry Norman, Dabinett, Knotted Kernel, Medialle d'Or, Rouge Bruyere, Strawberry Norman and two trees of each of the following varieties of perry pears: Barland, Butt, Oldfield, Moorcroft, Pine and Taynton Squash.

The orchard was in splendid condition, the trees on the whole were remarkably healthy and clean, well developed and with excellent heads. Cap of Liberty and Fair Maid of Devon were very fine specimens. Only three varieties did not come up to the high standard of the rest. These were Cherry Pearmain, Dabinett and Medaille d'Or. The first two were rather undersized, especially Dabinett, which had not done well. The Medaille d'Or trees were useless, the thin spreading branches characteristic of this variety being mostly broken down.

All the perry pears were in very good condition. All the trees were very clean and had been sprayed with caustic soda in 1920.

This orchard, previous to 1920, in which year it was broken up, had been in pasture. It was cropped with potatoes in 1921.

The trees were given two dressings of farmyard manure shortly after planting, and in 1916 a dressing of basic slag at the rate of 10 cwts. per acre was given.

The soil is very heavy—especially the subsoil—the percentages of both clay and fine silt being high. It also contains many stones—small-pieces of sandstone.

The surface soil and subsoil contain high percentages of total potash, whilst the amounts of available potash in them are low. The amounts of total phosphoric acid are low, whilst those of available phosphoric acid are fair. There is no carbonate of lime present in the soil and both surface soil and subsoil have small lime requirements.

Newnham Court, Tenbury.—Geological Formation, Old Red Sandstone.

The orchard was planted during 1908 and 1909 with the following varieties : Broadleaf Jersey, Broadleaf Norman, Knotted Kernel, Medaille d'Or, Strawberry Norman and Cherry Norman.

This orchard is situated on a fairly steep hill. On the top of the hill where the soil is rather shallow the trees have done rather badly, but on the lower parts they are more satisfactory. The variety that has given the best results is Broadleaf Jersey. The trees were well developed, of a good size and carrying a fair crop of highly coloured fruit. The next in the order of merit was Knotted Kernel. The trees of this variety had good heads and were of a fair size. The Strawberry Norman and Cherry Norman trees were not quite up to the standard of the other varieties, especially the last named, which were lacking in size. The Medaille d'Or trees had been quite unsuccessful and all the trees had been regrafted.

The soil varies in depth in this orchard, being only about 9ins. deep on the brow of the hill and over 18 ins. deep lower down the slope.

The orchard is normally stocked very heavily. A dressing of basic slag was applied in 1914 or 1915.

The surface soil sample is a general one for the orchard, but the subsoil sample was taken from the area on the brow of the hill.

The mechanical analyses show the surface soil to be very close textured, containing very little of the coarser fractions, and the subsoil—which is sharply defined from the surface soil—to consist chiefly of the middle fractions—fine sand and silts.

The chief points in the chemical analyses are the high percentages of total potash in the surface soil and subsoil ; the low total phosphoric acid in both samples ; and the remarkably high available

phosphoric acid in the subsoil. The surface soil contains a trace of carbonate of lime, whilst the subsoil contains none, though it has no lime requirement.

Powick Asylum.—Geological Formation, New Red Sandstone, Keuper Marl.

The varieties planted in 1908 were the following: Foxwhelp, Hereford Redstreak, Broadleaf Norman, Eggleton Styre, Knotted Kernel and Strawberry Norman. All the trees have done fairly well but are lacking in size. Broadleaf Norman, Hereford Redstreak and Knotted Kernel were the best developed. The trees were bearing for the first time. The crop was a moderate one.

It is probable that this land has been in pasture for 45 years, before which period it was arable.

During the last 10 years the land has been liberally manured, three dressings of basic slag having been applied during this period. Pigs have been run in the orchard for the last three years.

Both the surface soil and the subsoil are very heavy, containing high percentages of fine silt and clay. The total potash is high in both samples and the available potash is very satisfactory in the surface soil. Total phosphoric acid is fairly good in both surface soil and subsoil, but the available phosphoric acid is low in the latter.

Both samples contain a large percentage of carbonate of lime—the amount in the subsoil being especially high.

Hyde Farm, Upton-on-Severn.—Geological Formation, Alluvium.

The trees were planted in 1908, and the orchard contained the following varieties: Kingston Black, Court Royal, Ecarlatine, Harry Masters, White Jersey and Fair Maid of Devon. Nearly all the trees in this orchard were small and poorly developed. The supporting stakes had been removed too early and as a result of this several trees had blown down. Court Royal and Fair Maid of Devon were the best of a poor lot. The Kingston Black trees were rather unsatisfactory.

No details were available regarding the stocking and manuring of this orchard.

The mechanical analyses of the samples of surface soil and subsoil show the texture to be similar to that of the Powick soil.

The percentage of total potash is high in both samples, whilst the percentage of available potash is fairly high in the surface soil.

Total phosphoric acid is satisfactory in both samples, whilst each contains a high percentage of available phosphoric acid. Both surface soil and subsoil contain carbonate of lime.

Woollas Hill, Pershore.—Geological Formation, Lower Lias.

Three cider and two perry varieties were planted in 1908: Foxwhelp, Skyrmes Kernel and Sweet Alford; Barland and Oldfield.

Foxwhelp is the only variety that has not done well in this orchard. The trees are much too small for their age, but otherwise are in healthy condition. The Sweet Alford trees were very good, having well-developed heads and the same was the case with Skyrmes Kernel. The Barland trees were remarkably big and splendidly developed. The Oldfields have also formed very good trees.

The orchard forms part of a very old pasture and of recent years it has been very heavily stocked with cattle, which have been fed with cake.

The soil appeared to be very deep.

The textures of both the surface soil and subsoil are similar to those at Powick and Upton.

Although the amounts of total potash in the surface soil and subsoil are large, they are much smaller than in the samples from Powick and Upton.

The available potash is low in both samples. The percentages of total phosphoric acid are fairly high in both samples, whilst the amount of available phosphoric acid in the surface soil is poor and very poor in the subsoil. The surface soil contains no carbonate of lime and shows a lime requirement, whilst the subsoil contains a trace of carbonate of lime.

The Stocks, Suckley.—Geological Formation, Old Red Sandstone.

The following four varieties were planted in 1908: Cherry Pearmain, Kingston Black, Knotted Kernel and Strawberry Norman. All the trees were rather small but otherwise in healthy and clean condition. The Strawberry Norman trees had done best in the orchard and were carrying a good crop. The Kingston Blacks were only moderately good and the two other varieties were decidedly undersized.

The herbage in this orchard was in excellent condition, being nicely grazed and containing a large amount of white clover.

The soil appeared to be of great depth, was devoid of stones and easily friable.

The mechanical analyses show the soil to be a sandy loam with a texture typical of the soils of the Old Red Sandstone Formation. The dominant fraction is the "Fine Sand," of which a higher percentage is contained in the subsoil than in the surface soil.

The total potash is fairly high, but the available potash is very low in both samples.

The percentage of total phosphoric acid is low in both samples and whilst the available phosphoric acid is not high in the surface soil, it is low in the subsoil.

Neither samples contain carbonate of lime and both show a lime requirement.

Herefordshire.

Burghill Asylum.—Geological Formation, "Drift" over Old Red Sandstone.

Twelve trees of each of 25 varieties were planted in 1908. In 1919 all the trees had cropped heavily, but as the heads were two spreading and too strongly developed in proportion to the trunks they were cut back hard. On the whole the trees have developed satisfactorily, but towards the top of the slope many of the trees have only made moderate growth. Previous to the breaking up of the sod in this orchard in 1916 the whole of the trees had made poor growth. The following varieties were the most successful: Fair Maid of Devon, which were probably the finest trees in the orchard and which were carrying a splendid crop, Sweet Alford, Eggleton Styre, Improved Pound, Court Royal, Cap of Liberty, Strawberry Norman, Sweet Coppin, Knotted Kernel, Broadleaf Jersey, Cherry Norman and Killerton Sweet. All of these were very satisfactory. Foxwhelp, Skyrmes Kernel, Butleigh No. 14, Dabinett, Redstreak, Yarlington Mill, No. 32, and Kingston Black Improved were not quite such well developed trees. The Kingston Black trees were also on the small side, especially on the higher part of the orchard, which is rather wind-swept. The Cowarne Red trees had suffered from canker but were recovering. All the Medaille d'Or trees had been more or less broken down by the wind and had all been regrafted with other varieties.

Previous to 1916, this orchard had been for many years a pasture of poor quality which had occasionally been put up for hay.

The trees were planted whilst the sod was in this poor condition. In 1916, the pasture was ploughed up and since that date the land has been cropped with arable crops and has received generous manurial treatment. The orchard is situated on a fairly gentle slope and the soil near the top of the orchard is shallow and of a gravelly nature, whilst on the lower areas of the slope the soil is less stony and is much deeper.

The soil samples were taken from the lower portion of the orchard.

It will be seen from the mechanical analyses that both the surface soil and subsoil contain large percentages of stones and fair amount of coarse sand. The percentages of the middle fractions present are fairly high, whilst the percentages of clay are not high.

The total potash is fairly high in both samples, whilst the available potash is low in the subsoil. The percentages of total phosphoric acid is high in the surface soil and only moderate in the subsoil. The amount of available phosphoric acid is very high in the surface soil and very low in the subsoil. This difference may have been produced to a great extent by the recent dressings of phosphatic fertilisers which have been given. Both samples contain small amounts of carbonate of lime.

COUNTY CIDER ORCHARDS—PLANTED 1908.

Worcestershire and Herefordshire.

Mechanical Analysis.	Madresfield Court, Malvern.	Newnham Court, Tenbury.	Powick Asylum.	Upton-on-Severn.	Woollas Hill, Pershore.	The Stocks, Suckley.	Burghill Asylum.*
	%	%	%	%	%	%	%
Surface Soil—							
Stones	10·70	nil	3·50	2·10	nil	nil	22·00
Fine Gravel	4·69	0·13	2·09	1·70	0·30	0·41	2·77
Coarse Sand	9·10	2·62	10·59	6·95	4·47	3·35	15·74
Fine Sand	20·73	19·30	12·60	14·97	13·71	32·16	28·18
Silt	17·91	26·71	9·84	14·10	15·12	23·60	20·32
Fine Silt	24·59	27·82	20·97	23·42	27·03	22·98	17·07
Clay	14·58	12·99	25·51	23·74	23·09	9·36	8·47
Subsoil—							
Stones	17·40	nil	3·20	6·3	nil	nil	29·20
Fine Gravel	5·43	nil	1·71	1.59	0·21	0·23	5·16
Coarse Sand	8·04	0.27	5·71	4·58	3·52	3·77	16·04
Fine Sand	19·50	19·63	10·27	12·76	12·15	38·91	29·76
Silt	16·61	35·68	8·50	11·59	12·80	21·42	18·69
Fine Silt	23·02	31·47	23·97	23·20	25·26	19·80	16·45
Clay	20·56	6·02	31·81	35·36	33·96	10·83	8·25

COUNTY CIDER ORCHARDS—Continued.

Chemical Analysis—							
Surface Soil—							
Moisture	2·18	2·84	4·00	3·58	3·82	1·97	1·40
Loss on Ignition..	5·26	5·52	9·28	9·26	11·06	4·96	4·88
Potash (Total) K_2O	1·041	1·228	1·516	1·747	0·792	0·603	0·625
Ditto (Available) K_2O ..	0·0063	0·0139	0·0232	0·0158	0·0080	0·0046	0·0118
Phosphoric Acid (Total) P_2O_5 ..	0·110	0·092	0·161	0·165	0·178	0·080	0·195
Ditto (Available) P_2O_5 ..	0·0161	0·0284	0·0332	0·0342	0·0079	0·0121	0·0967
Carbonate of Lime	nil	0·081	2·40	0·278	nil	nil	0·094
Lime Requirement	0·165	nil	nil	nil	0·309	0·185	nil
Subsoil—							
Moisture	2·32	3·02	4·22	3·31	3·88	1·52	1·14
Loss on Ignition..	3·94	3·74	5·64	5·26	6·94	3·16	3·34
Potash (Total) K_2O	1·307	1.330	1.838	2·277	0·929	0·600	0·629
Ditto (Available) K_2O ..	0·0043	0·0033	0·0099	0·0110	0·0056	0·0035	0·0065
Phosphoric Acid (Total) P_2O_5..	0·090	0·099	0·122	0·149	0·155	0·049	0·109
Ditto (Available) P_2O_5 ..	0·0136	0·0769	0·0074	0·0496	0·0034	0·0063	0·0040
Carbonate of Lime	nil	nil	6·70	1·20	0·009	nil	0·047
Lime Requirement	0·103	nil	nil	nil	nil	0·124	nil

* Denotes Herefordshire orchard.

THE APPLE BLOSSOM WEEVIL: ITS LIFE-HISTORY AND CONTROL.

By Herbert W. Miles.

In 1920 a summary of the life-history of the Apple Blossom Weevil was given in the Annual Report of this Station, and since that time the details of the life cycle have been traced through two seasons, and some work has been carried out on control measures. The detailed accounts of this work have appeared elsewhere*, but it is thought advisable to include here an outline of the life-history emphasising important points and an account of suggested methods of control.

Life History.

The first appearance of the weevil in the plantations is towards the end of March. The insects leave their winter quarters, and may be seen crawling actively about the apple and pear trees, piercing the developing fruit buds and feeding on the juices accumulating near the growing point. This activity occurs in bright sunshine and at about mid-day the weevils can be seen in greatest numbers, stimulated, apparently, by the sun's warmth. The first spring feed excites the sexes and mating takes place in the branches. At this period the weevils are seldom seen on the wing; they are very sensitive to the least touch or jar to the branches, and fall immediately with folded limbs. Feeding and resting take place alternately until early in April, when egg-laying commences. By this time the buds have reached that stage of development known as the cluster-bud stage, *i.e.*, when the inflorescence buds are in a firm, compact cluster, surrounded by a rosette of foliage leaves. The interval between mating and egg-laying varies from a fortnight in an early season to three weeks in a late one. The act of oviposition is as follows: The female selects the inflorescence bud to be operated on, and, by means of the sharp mandibles, located at the apex of the rostrum, or snout, drills a hole, rejecting the surface tissue of the calyx. The rostrum is then thrust downward, practically its whole length, into the compact tissue of the bud, and the head is rotated from

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* *Journ. Min. Agri.*, October, 1922; *Journ. Pomology*, January, 1923.

side to side as the drilling proceeds. The insect then remains still for about ten minutes, while a cavity is gnawed into the lobe of the anther, which is located immediately below the hole in the calyx. The rostrum is then withdrawn and the insect, reversing her position, extends the ovipositor, which is thrust into the prepared aperature and an egg is deposited in the cavity in the anther lobe, an act taking about two minutes. The period occupied by the whole process varies from 15 to 20 minutes. When the act is completed and the ovipositor withdrawn, a sappy exudate from the damaged tissue fills the aperature in the calyx, and, congealing, effectively seals the opening. During the ovipositing period the females may be found secreted in the inflorescence clusters and in the small notches amongst the fruit spurs. Feeding on the flower buds continues for two to three weeks after the first sign of oviposting.

The eggs hatch in from eight to thirteen days, the time varying with the weather conditions prevailing. On hatching the minute larvæ are soft, white, legless grubs with a much wrinkled, slightly hairy body and a large dark-coloured head. These young larvæ commence feeding on the pollen in the anther lobes, completely destroying the stamens, the styles, and, finally, even attacking the surface of the receptacle. The curious " capped " effect of infested blossoms is produced by the larvæ gnawing through the bases of the petals, which wrinkle, turn brown, and remain attached to the receptacle by a few strands. These brown petals are folded together and form a dome-shaped cap under which the larval and pupal stages are spent. The larval stage lasts for 15 to 17 days, several moults taking place as development proceeds. The fully-fed larvæ are dirty white or creamy-coloured, and present a mottled appearance owing to the brownish stomach contents showing through the outer skin. Just prior to papating, however, the larvæ assumes a clear, light, yellow appearance. The pupæ are yellowish, soft and fleshy, and are clothed laterally and dorsally with numerous stout bristles. The limbs, antennæ and rostrum are folded in characteristic fashion and can be seen through the transparent pupal coat.

The pupal stage is from five to eight days in duration, and at the end of this period the fully developed weevil sheds the pupal coat, and, after hardening up beneath the shelter of the capped blossom, cuts a circular exit hole and escapes.

The newly emerged adults are very active and fly much more readily than the over-wintered form. They feed on the petals of any late blossom, and on the under-surfaces of foliage leaves of apple and plum, rejecting the lower epidermis, but destroying the mesophyll or internal leaf tissue, and leaving the upper epidermis intact. The young adults feed and rest alternately though not so markedly as to over-wintered adults, and any cold weather in summer causes them instantly to seek shelter under the rough

bark of orchard trees or in canker spots. The first appearance of the young adults is in May, the majority are fully fed by the end of June, and in a normal season seek winter quarters from early July. The winter sites selected are in rough bark on main branches and trunks of orchard and forest trees, in cankered areas about trees, under paper of old grease-bands, and in the soil.

Natural Enemies.

The principal agents in controlling the Apple Blossom Weevil are birds, fungi and insects. Woodpeckers, nuthatches and chaffinches take the adults and sparrows are recorded to peck open the capped blossom and destroy larvæ and pupæ. A fungus which was in evidence at Long Ashton attacking the over-wintering adults, was apparently a species of *Isaria*, a common insect-attacking fungus. Of parasitic-insects checking the increase of the weevil the principal species is *Pimpla pomorum*, Ratl., an Ichnemonon fly. This species parasitised weevils at Long Ashton in 1921 to the extent of 5 per cent.

Control Measures.

Among the measures suggested for the control of the Apple Blossom Weevil, spraying, jarring, and banding have been variously recommended, as also has the collection of the capped blossom and the liberating of any parasites which may develop on the contained larvæ and pupæ of the pest. Jarring yields satisfactory results where it can be constantly followed in small plantations of bush-trees, but a difficulty apt to be met with is that on dull days the weevils refuse to fall on jarring, and on bright still days many falling as a result of the jar spread their wings and fly to adjacent trees. In France collecting capped blossom and liberating the Ichneumonid parasites was found to have very far-reaching effects and is well worth a trial where the trees are small enough to be within reach of the ground. Where step-ladders have to be used this treatment becomes more laborious and expensive. As regards banding the principle is to provide a shelter, under which the fully-fed insects will secrete themselves for resting or hibernation ; sacking, brown paper, or corrugated paper is quite satisfactory. The bands should be periodically examined and the weevils collected and destroyed by crushing or dropping into paraffin. In order to trap weevils going into hiberation the bands should be in position by the middle of June.

Spray Treatment.

Since caustic soda and lime wash have been advocated from time to time it was thought advisable to test these two sprays at Long Ashton, and in 1921 trials were made, the weevils, however, success-

fully withstood the treatments, remaining quite unaffected by the caustic soda and being found feeding with lime still adhering to them. Since the over-wintered weevils reject the surface tissue when feeding at the buds and the young adults when feeding on the lower surface of the foliage leaves discard the epidermis, poison sprays such as lead arsenate, are useless.

Numerous substances and proportions were tried at Long Ashton, but the only spray selected for trial in a grower's plantation was an unstable paraffin-emulsion consisting of :—

Potash Soft Soap (Liquid form) ..	·5%
Paraffin	10%
Soft Water	89·5%

This spray required thorough emulsification and was constantly agitated while being applied. On touching the trees the emulsion broke down and the paraffin " crept " into all cracks and crevices amongst the bark, killing the weevils within about a quarter of an hour. The important points to remember about using this spray are the time of application, viz., late in February or early in March, before any signs of bud bursting are visible ; and the need for constant stirring while it is being applied. The spray need only be directed against spots likely to harbour the weevils, such as rough bark, gnarled areas, cankered areas and growth cracks. Used thus in Worcestershire in 1922, 20 gallons of spray was found to be sufficient for about 60 bush trees.

The only other spray which has been found to have any bearing on Apple Blossom Weevil control, is Lime Sulpher. When this spray is used annually as an insurance spray it is found to dry the bark and render this site practically totally unsuitable as winter quarters for the weevil, which select those sites where a certain degree of moisture is maintained throughout the winter.

As suggested elsewhere,* no one method is likely to yield complete control of the Apple Blossom Weevil, but where two or three measures can be employed in conjunction, in a plantation, a reasonable freedom from the pest is obtainable, and the paraffin emulsion herein referred to is certainly worthy of consideration by growers who are troubled with this pest.

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* *Journ. Ministry of Agric.*, Oct., 1922.

STATISTICAL STUDIES ON THE PROPAGATION OF BIG BUD AND REVERSION DISEASE OF BLACK CURRANTS.

By A. H. Lees.

I.—Reversion.

In 1920 a small planting of Black Currants was made at Long Ashton in order to provide material for the study of these two diseases and also where possible to obtain crop records. The plantation consists of about 550 plants. The ground was in good condition at the time of planting and has been well treated manurially, so, though slightly shaded by standard apples, the bushes have made good growth.

The varieties selected follow Hatton's grouping and are respectively Edina, Boskoop Giant, Seabrook's Black, and Baldwin. Of this latter variety two strains A and B are being tried. The young plants were bought as two-year-olds, the Edinas being supplied by a grower and the other varieties by three different first-class nursery firms.

They represent therefore the sort of material that a grower might expect to receive if he went to the best sources. In fact since they were bought by a Research Station openly it might be expected that they would, if anything, be better than the average. It is interesting therefore to note the amount of reversion occuring during the first summer. This figure may be taken to represent accurately the amount of reversion present when the bushes were bought, since, as far as is known, there is no chance of fresh infection showing itself by the end of May, at which time the amount of reversion was marked down.

TABLE I.

Reverts in First Summer after Planting.

Variety.	Reverts.	Total. Bushes.	% Reverts.
Edina	23	114	20
Boskoop	5	123	4
Seabrook	9	134	7
Baldwin A.	0	57	0
„ B.	4	118	3

The grower's plants were therefore much inferior in this respect to that obtained from nursery firms, though even in these cases three out of four lots contained some reversion. The prospective grower should therefore be very careful in the choice of his source of supply.

Reversion Statistics.

The Edina variety was sufficiently badly infected to show the connection between Big Bud and Reversion, and below are set forth figures for this variety in the same manner as in the Annual Report for 1921 for another plantation. The present plantation, however, has the advantage that the features can be followed out from the start.

In the following tables N signifies freedom from reversion (normal). R reverted, O freedom from, and I presence of Big Bud. FR signifies fractionally revert.

Table II shows the association of O (absence of Big Bud) and of I (presence of Big Bud) with the three classes of reversion.

TABLE II.
var. Edina.

	Percentage of 0.		Percentage of 1.	
Occurring in Class.	1st year.	2nd year.	1st year.	2nd year.
N	85	91	61	33
FR	0	4	0	0
R	14	5	39	67

As in the other plantation the figures for normality and absence of Big Bud (NO) are high and also the figures for reversion and infection with Big Bud (RI). NI is also high especially in the first year showing that the first attack of mite does not usually produce reversion in bushes in the open. The predominant association of N with O and R with I is, however, shown by the fact that the figures for NO are always larger than those for NI and RI than those for RO.

TABLE III.
var. Edina.

Percentage in first year of.	Becoming in second year. N	FR	R
N	95	2	3
FN	0	0	0
R	4	4	92
NO	94	3	3
NI	93	0	7
FRO	0	0	0
FRI	0	0	0
RO	7	0	93
RI	0	12	88

Table III shows in the upper portion the percentages of first year normals, fractionally reverts and reverts that become normal, fractionally revert and revert in the second year.

Normals show a strong tendency to remain normal and reverts revert.

The influence of Big Bud on the subsequent behaviour of the bush as regards reversion is shown in the lower half of the table. Of the normal bushes 3% of NO become revert and 7% of NI. Of the reverts 7% of the RO become normal and 0% of RI, thus showing in both cases a slight tendency of Big Bud to cause reversion and freedom from Big Bud, normality. This plantation thus tends to confirm the results set out for the other plantation reported on in 1921. On the other hand it may be argued that the tendency for the high figures RI in Table II is due to the possibility that bushes reverted through other causes are more susceptible to Big Bud infection than are normal bushes. The only way to obtain figures on this point is to examine the behaviour of NO and RO bushes in the second year. That is if there is a difference in infectability of normal bushes free from Big Bud and reverted bushes free from Big Bud it ought to be possible to find it. Since these two classes both start free from Big Bud infection, if there is a difference it should be shown in the second year. There were 73 normal non-big budded bushes that remained normal (free from reversion) the second year. Of these 8 or 11% became infected with Big Bud the second year. There were 13 reverted bushes non-big budded that remained reverted the second year. Of these 10 or 77% became big budded as against 11% of the normals. The corresponding figures from the other plantation referred to were 18% normals becoming big budded and 72% reverts becoming big budded, which figures are in fairly close agreement. There would therefore appear to be a bigger tendency for reverted bushes to become attacked with Big Bud than for normal bushes. It does not follow, however, that cause and effect act in this direction only. Evidence has already been cited showing a tendency for infection by Big Bud to cause reversion, and furthermore, if Big Bud did not cause reversion then it should be possible to find highly big budded bushes that were normal. No such bushes have been found so far at Long Ashton nor have they been observed elsewhere by the writer.

II.—Big Bud.

The total percentages of Big Bud in the four varieties is shown in Table IV for all the varieties.

TABLE IV.

Variety.	Percentage Big Bud during three years.		
	1st year.	2nd year.	3rd year.
Edina	73	21	26
Boskoop	2	1	3
Seabrook	0	0	0
Baldwin A.	0	2	4
„ B.	2	3	8

The drop in attack in the second year was due partly to the fact that all big buds were carefully destroyed at planting time. There was, however, a source of infection left about ten yards beyond the Baldwin B group.

The table appears to show the relatively great susceptibility of Edina, a character that is fairly well known to nursery growers.

The plantation of Edinas, beside furnishing evidence of the association of Reversion with Big Bud, has also supplied statistics showing the natural spread of Big Bud. Table V. shows the numbers of infected and free for the winters of 1920, 1921 and 1922, and also the numbers and percentages of free and infects becoming in the next year free or infected. The figure O signifies freedom from, and the figure I presence of Big Bud for each of the three years.

TABLE V.

var. Edina.

Constitution.	No.	Constitution.	1920–21. No.	%	1921–22. No.	%
000	20	10	65	78	14	58
100	51	11	18	22	10	42
010	3	00	26	82	71	78
001	6	01	6	18	20	22
110	11					
101	14					
011	3					
111	7					

This variety was obtained from a market grower and showed the very big percentage of 73 of big budded plants. They were, however, planted. Great care was taken to remove all big buds after planting, so that the following year no mite should be present unless they wintered in some unknown position, as for example in the soil or on the bark.

Table V shows the history of these bushes for the three years 1920-22. There were thus 20 bushes that were free all three years, 51 that were infected the first and free the last two years and so on. The right-hand half of the table shows the history of bushes from one year to the next. Of the infects in 1920, 78% were free in 1921, and 22% infected, and of the free in 1920, 82% remained free and 18% became infected. Thus the percentage of infects in the second year from first year infects was almost exactly the same as the percentage of infects in the second year from first year frees. In other words, it made no difference whether the bush was originally infected or free and the infection clearly came from some source independent of the bush itself.

The figure for this natural increase for the conditions under which the experiment was made was therefore about 20%. The following pair of years 1921-22 showed rather different figures. While the percentage of frees becoming infected was still about 20 (22 actual), the figure for infects remaining infected had gone up to 42. This was because no attempt was made in the winter of 1921 to eliminate Big Bud and consequently there were two sources of infection for infected bushes, one from the bush itself and the other from highly infected bushes outside the plantation. These highly infected bushes were probably responsible for the 20% increase found from 1920-21. Substracting the " natural increase " of 20% from the total for 1921-22, 22% is obtained for the increase due to Big Bud on the bush. Thus under these conditions and with an initial attack only one fifth of the bushes re-infected themselves.

The susceptibility of the variety Edina appeared to be particularly marked. Between the source of infection were six rows of Baldwin, five of Seabrook's Black and five of Boskoop Giant. Nevertheless re-infection of the Edinas was well marked, while hardly any occurred on the other varieties nearer the source of infection.

EGG-KILLING WASHES.

By A. H. Lees.

Every year the fruit grower is confronted with the necessity of spraying his bushes and trees in order to control insect pests. Many of these insects spend the winter in the egg form on the plants and are thus of particularly easy access at that time of the year. Most of the aphis pests lay winter eggs on the trees, *e.g.*, three kinds of apple aphis, the leaf-curling plum aphis, cherry aphis and the aphis attacking gooseberries and currants. In addition, on the apple, eggs of apple sucker and capsids also occur, while red spider eggs may be found on many fruit trees.

It would be, therefore, clearly advantageous to the grower if some reliable egg-killing wash could be found. At one time the possibility of obtaining a wash that would kill insect eggs was looked upon as almost, if not quite, impossible, in view of the very resistant nature of the chitin which forms the egg shell. Further suspicion was cast upon the idea by the failure of the claims of certain winter-wash manufacturers for egg-killing properties for fluids which had no such action. Nevertheless, recent work has shown that certain fluids, such as lime-sulphur, have the property of killing certain eggs if applied at certain strengths and at certain times. Field work also has tended in the same direction, in the case of lime-sulphur, cases being fairly frequent where delayed dormant spraying has given a fair control for aphis.

There were, therefore, good reasons for investigating the subject more fully under laboratory conditions and a beginning was made in the winter of 1922. The material selected was the eggs of the permanent apple aphis, *Aphis pomi*, which frequently occur in large numbers on apple twigs. A number of egg-infested maiden plants were potted up and kept under outside conditions. The wood was marked off in lengths of four inches for treatment. Between each treated portion was left a length of one inch, to act as a buffer between treatments. The fluids were painted on with a soft brush, great care being exercised to prevent over-lapping. With some of the very wetting fluids this was not easy. As soon as the fluids were dry the trees were removed outside again. They were thus not kept in the laboratory more than three hours.

Substances Tested.

These consisted of proprietary fluids (A and B), lime sulphur, red oil, paraffin emulsion, mercuric chloride and various mixtures of caustic soda and nicotine. Trials were made from the middle of January to the middle of April. The control portion was left either at the tip or base of the stem.

Procedure.

As soon as hatching showed signs of beginning the potted trees were taken inside and the buffer inches greased to prevent the eggs hatching. The plants were then laid horizontally with sheets of oiled paper close below them. As the aphids hatched in most cases before the buds started there was no green tissue for them to feed on and they fell on to the oiled paper and were caught and counted. After hatching was completed the stems were cut and the total number of eggs computed. The portion of twig was first boiled in caustic soda to remove the egg shells. The solution was then filtered and the residue with eggs washed into a litre of water. After thorough agitation a measured portion of the egg-containing water was removed by a pipette and the eggs counted. The average from six counts were found to give a figure with only a small probable error.

The results of each tree are given below :—

TREE I.—TREATED JANUARY 19TH.

	Lime-Sulphur.				Paraffin Emulsion.		Control.
	1 in 10	1 in 12	1 in 15	1 in 20	15%	25%	
Eggs hatched	0	3	0	4	4	2	9

These results are so unsatisfactory that they must be neglected.

TREE II.—TREATED FEBRUARY 17TH.

	Lime Sulphur.				"A."	"B."	Red Oil.	Par. Em.	Control.
	1 in 20	1 in 15	1 in 12	1 in 10			5%	15%	
Eggs hatched	3	12	19	17	5	7	77	60	78
Total Eggs present*	813	1,617	1,320	1,866	1,833	1,443	1,320	1,160	446
% hatched	.37	.74	1.44	.91	.29	.48	5.8	5.2	17.5

* Computed.

This tree showed well-marked influence of the fluids used. All strengths of lime sulphur as well as "A" and "B" gave good

control, while red oil and paraffin emulsion gave only a partial control.

TREE III.—TREATED FEBRUARY 23RD.

Caustic Soda .. .. .. 2% Nicotine 0%	1% .05%	1% .1%	2% .025%	2% .05%	2% .1%	Control.
Eggs hatched 43	6	2	6	2	2	17
Total eggs present* .. 896	2,000	2,616	1,586	2,050	1,300	820
% hatched 4,8	.3	.07	.38	.01	.05	2.07

* Computed.

In this case the number of eggs hatched in the control is very unsatisfactory, but there is an indication that where nicotine was used the kill was materially increased.

TREE IV.—TREATED APRIL 20TH.

Mercuric Chloride	1 in 4000	1 in 2000	1 in 1000	1 in 500	Control.
Eggs hatched	642	534	601	411	520
Total eggs present*	5,514	7,000	6,626	5,480	—
% hatched	11.6	7.5	9.1	7.5	—

* Computed.

The control was accidentally destroyed before the total eggs present could be estimated, but it was evident that mercuric chloride had no egg-killing power.

TREE V.—TREATED MARCH 15TH.

	Control.		Lime-Sulphur. 1 in 20	1 in 15	1 in 12	1 in 10	"A"	"B"	Par. Em. 15%	Red Oil. 5%	Soda 2% Nicotine .1%	Merc. Chlor. 1/500
Eggs hatched	23	131	6	4	14	34	18	21	463	211	9	36
Total eggs present*	320	912	967	2,048	3,300	6,168	4,980	5,900	5,132	3,633	1,853	1,720
%hatched	7.2	14.4	.62	.19	.42	.55	.36	.36	9.2	5.8	.48	2.1

* Computed.

In this experiment lime-sulphur and "A" and "B" have again given satisfactory control at all strengths used. The results which were only indicated in Tree III for soda and nicotine are shown here more clearly, a good control being obtained for caustic soda 2%, nicotine ·1%. Paraffin emulsion, red oil and mercuric chloride were again unsatisfactory.

TREE VI.—TREATED APRIL 11TH.

	Control.		Lime-Sulphur.			
			1 in 20	1 in 15	1 in 12	1 in 10
Eggs hatched	500	160	96	40	44	46
Total eggs present*	1,975	8,240	8,400	7,314	4,964	6,675
% hatched	25.3	2.4	1.2	.47	.6	.96

* Computed.

Here again the effect of lime-sulphur is shown as in previous experiments. The variation between the controls is, however, high.

Conclusions.

It is not possible to draw very decided conclusions from one year's experiments, but there are distinct indications that both lime-sulphur and fluids "A" and "B" have very decided killing properties for eggs of *Aphis pomi*.

Summarising the figures for lime-sulphur the following figures are obtained :—

%Eggs hatched after Lime-Sulphur Treatment at various strengths.

Strengths.	Date of Application. February.	March.	April.
1/20	·37	·62	1·2
1/15	·67	·19	·47
1/12	1·36	·42	·6
1/10	·86	·28	·96
Control	17·5	7·2	25·3
„		2·4	2·4

These figures appear to show that there was no clearly marked difference obtained from the various strengths or times of application. On the whole the March application showed a slight superiority, but the difference is quite small.

Fluids "A" and "B" showed a slight superiority over lime-sulphur. Mercuric chloride was of no appreciable use.

The caustic soda-nicotine trial did not secure a big enough hatch to be reliable, but it indicates that an increase in percentage of both soda and nicotine result in a high killing power.

SPRAYING FOR THE CONTROL OF THE LOGAN BEETLE.

By G. S. Peren.

In continuation of the work reported in the Annual Reports of the Research Station, Long Ashton for 1920 and 1921, a further trial of arsenate of lead for the control of the logan beetle was carried out this year on lines similar to those of last year's experiment.

Twelve rows of logans were used. Three-quarters of each row was sprayed and the remaining quarter left as control.

The first spraying was applied when approximately one third of the blossom was out, the second, when two-thirds were out, and the third when the bushes were in full bloom.

The following formula was again used :—

Arsenate of lead	4lbs.
Water	100 galls.
Pressure of application	125lbs. per sq. inch.
First application	May 31st
Second application	June 3rd.
Third application	June 10th.

A fine nozzle was used and the spray driven right into the blossoms.

The results are given in Table I and show that the sprayed berries averaged 2.6% infected, while the unsprayed berries averaged 9.1% infected. The last four pickings may, however, be again disregarded, being light and of little value, thus giving an average of 1.9% infected for the sprayed plot and 9.3% infected for the control.

The percentages infected for the control plot are low when compared with the corresponding figures for 1921 and 1922. This is probably due to two causes—firstly the fact that the major portion of the loganberry plot is receiving a spray which is rapidly exterminating the beetle population and thus diminishing available material

for the trials, and secondly to the reported "off" year for logan beetles. In order to test more fully the efficiency of the sprays, the control area for 1921 was this year brought into the sprayed portion and an area which was sprayed last year was this year used as a control. It is of course quite possible that this procedure lowered the figures for this year's control.

The results for the last three years are as follows :—

	Sprayed.	*Unsprayed.*
1920	15% infected.	24% infected.
1921	4·9% „	19·8% „
1922	2·6% „	9·1% „

It is reasonable to suppose that the figures for 1920 would have been lower had three applications instead of two been made. From these figures it appears evident that arsenate of lead is quite reasonably effective in controlling the beetle, and the figures for 1922 strengthen the hope expressed in the previous report that after three years efficient spraying it will be possible to dispense with spraying for one or two years, provided there are no sources of infection near-by.

The results are considered sufficiently good to warrant the commercial application of this treatment, and so, in conjunction with further trials, to establish proofs thoroughly it is proposed to test as deterrents to bees and other pollinating insects various substances which can be mixed with arsenate of lead. A few dead bees have been noticed in the plantation after spraying, but a stock of bees belonging to the Station did not appear to have suffered although only some 200 yards from the plot containing 30 perches of sprayed bushes. The set of the fruit has each year been very satisfactory.

In addition to the work with arsenate of lead a very strong paraffin emulsion as suggested by Theobald was tried the formula being :—

Soap	40 lbs.
Paraffin	8 galls.
Water	100 galls.

This spray was applied in the same way and at the same time as the first application of arsenate of lead.

Very severe scorching of the leaves followed this application in spite of very complete emulsification when mixing the materials, and only a few examinations of fruit were made as this treatment appeared too dangerous to be of use.

The results obtained are given in Table I and the figures show a small measure of control which might have been greater had it been possible to give three applications.

In both 1920 and 1921 there frequently appeared to be a decided difference in size and quality between the apparently un-

TABLE I.

Date of Picking.	Sprayed with Arsenate of Lead.			Sprayed with Paraffin Emulsion.			Unsprayed.		
	No. of Berries Examined.	Infected.		No. of Berries Examined.	Infected.		No. of Berries Examined.	Infected.	
		Number.	Percentage.		Number.	Percentage.		Number.	Percentage.
July 13	251	6	2·4				259	28	10·8
,, 17	216	2	0·9	233	11	4·7	193	7	3·6
,, 19	230	0	0·0				246	24	9·7
,, 21	233	10	4·3	295	21	7·1	234	24	10·2
,, 25	207	1	0·5				217	26	12·0
,, 27	214	3	1·4	263	18	6·8	235	24	10·2
,, 31	206	5	2·4				229	20	8·7
Aug. 4	268	3	1·1	261	7	2·7	246	12	4·9
,, 9	229	4	1·7				262	8	3·0
,, 11	275	11	4·0				305	29	9·5
Totals	2329	45	1·9	1052	57	5·4	2426	202	8·3
Aug. 13	286	9	3·1				304	29	9·5
,, 15	316	18	5·5				352	42	11·9
,, 18	159	9	5·7				163	18	11·0
,, 21	140	4	2·9				139	17	12·0
G. Totals	3230	85	2·6	1052	57	5·4	3384	308	9·1

infected berries of the sprayed and unsprayed plots. This difference was again apparent this year, especially in good ripening weather, and appeared to be due to very minor damage by the larvae of the logan beetle and possibly other insects, which had had a stunting effect on the berries. As it was felt that this should be taken into account, it was decided to make counts of the number of berries infected and otherwise in 2lb. net of fruit from each treatment at each picking, and this was commenced with the third picking on July 19th and continued to the end of the season. The figures obtained were as follows :—

	Sprayed.	*Unsprayed.*
Average number of berries per 1lb. net of fruit	125·5	133·3

This equals a saving of 7.8 berries per lb. and 17,472 berries per ton. This at 125.5 berries to the pound equals an increase of 139lbs. which at 6d. per lb. would be worth 69s. 6d.

Sixpence per lb. was the average price for the entire crop marketed by the Station this year.

If these figures be applied to a crop of 2½ tons per acre, the increase gross profits equals £8 13s. 9d. This presupposes a similar price for both sprayed and unsprayed fruit, whereas the former when at their best would probably make a slightly better price, especially if the distance to market were considerable.

The cost of spraying must naturally vary with the type of spraying machine used, the proximity of the water supply, freedom from breakdown, etc. At this Station it is estimated that the cost per acre per spraying works out as follows :—

	£	*s.*	d.
Two men at 32/- per week of 5½ days, for one day ..	0	11	8
One carter at 36/- ditto, ditto	0	6	6½
One horse at 7/6 per day, for one day	0	7	6
32lbs. of arsenate of lead at 1/2 per lb.	1	17	4
	£3	3	0½

The estimate would not of course hold for all districts, but even if the round sum of £10 10s. per acre for three sprayings be taken as a safe covering figure, the deficit after substracting £8 13s. 9d., the increased gross profit is only 36s. 3d. per acre. It should be remembered, however, that this year the berries in the unsprayed plot were only 9.1% infected. It appears reasonable to assume that the spraying would have shown a profit last year when the unsprayed averaged 19.8% infected as opposed to 4.9% infected in the sprayed.

In order to find out both the extent to which the sprayings will pay for themselves in the year of their application and also the profit on the complete cycle of operations, it is intended to keep accurate crop records from the commencement of reducing a badly

infected plantation to some 2% infected, which is probably the limit of freedom obtainable, to the end of the period following this reduction, during which it will be unnecessary to spray.

Conclusions.

1. Arsenate of Lead appears to control the Logan Beetle effectively if applied when the blossoms are one-third, two-thirds and fully open.
2. The results warrant the commercial application of the treatment, especially if a deterrent to bees can be found which will mix with the Arsenate of Lead.
3. The first spraying, and possibly the second, should pay for themselves in the year of their application. The third spraying will probably show a slight loss, but it is hoped that it will prove possible to dispense with spraying for two years if the infection, after the third spraying, is only in the neighbourhood of 2%, in which case the complete cycle of operations should show considerable profit.
4. An 8% Paraffin Emulsion, while showing some measure of control, may cause severe scorching of the foliage and therefore cannot be recommended.

BARK CANKER DISEASE OF APPLE TREES, CAUSED BY MYXOSPORIUM CORTICOLUM, EDGERTON.

By Grace Gilchrist.

At Long Ashton, in 1920, a disease was noticed in a plantation of bush apple trees doing very severe damage to the branches. In some cases, only one branch was affected and in others the disease had reached the crown of the main trunk and the trees were doomed. A character of the disease was the formation of large longitudinal scars on the sides of the branches and this symptom together with the occurence of numerous pustules of spores of the fungus Myxosporium corticolum, Edgerton, led to the indentification of the disease as bark canker. Hitherto this disease had not been reported in this country, although it has been known in the United States since 1910.

The most characteristic feature of the bark canker disease is the extremely long narrow scars which it produces. These may run for a length of two or three feet down one side of a stem and not reach a breadth of more than 1½ inches. The disease may start at the top of one of the main branches and grow downwards, or it may develop from the soil level infecting the trunk and causing the rapid death of the trees. The dead area of the scar is somewhat sunken below the surrounding tissue owing naturally to the lack of new growth taking place. The edges of the scar are usually well defined by a rather deep crack and sometimes the formation of a callus round the healthy regions is noticeable during the summer. The dead tissue is usually found covered with innumerable small fructifications scattered over its surface. Under normal conditions merely the openings of the fructifications can be seen, but after a damp foggy night, the spores accumulate at the openings and can be recognised as small white points. These spores are oval or slightly allantoid in shape, although occasionally they are found to be quite curved. The end of the conidium nearest the conidiophore is somewhat bluntly pointed, while the other end is conspiciously rounded. The cell wall is comparatively thick. These conidia are unicellular.

hyaline in colour, and contain large refractive globules varying from 1 to 35μ in diameter. The conidia vary in length from 25μ to 45μ, and in width from 9μ to 18μ.

A rather unusual feature of this disease is the seasonal activity of the fungus. At only one period of the year do the scars increase and that is usually towards the end of the summer, but it varies according to the season. In 1920, at Long Ashton, they started growth in October. In 1921 a much earlier ripening year than 1920 they started in August, whilst in 1922, a late season, the very first signs of the extension of the scars was visible on June 19th, but it was not until September that this fungus was really active. After a comparatively short period, during which time the scars extend rapidly, the fungus becomes quiescent and remains so until the following year, when it once more bursts into new growth. The interesting point is that although the fungus is always present, and presumably ready to grow, yet it is only at one period in the annual cycle that it can do this. The cause of this is of course obscure, but one cannot help thinking that the physiological condition of the tree, or perhaps of the fungus, or possibly of both, alters during the time when growth of the fungus is just taking place. The first sign of any activity on the part of the parasite is the appearance of faint cracks in the bark for some little distance below a scar. These cracks, which at first may be entirely dissociated from any previous crack, become more distinct in a few days and finally become linked up to form a well defined line of demarcation at the edge of the bark canker, between the healthy and what subsequently becomes diseased tissue. The tissue within the crack browns and dies off, producing after some little delay the usual fructifications. These fructifications at first appear as dome-shaped swellings caused by the accumulation and growth of the fungus at various points just below the epidermis. The hyphae in the centre of these masses elongate perpendicularly to the epidermis and develop into a definite column of tissue, which forces the epidermis out. The hyphae round the base of the central column do not increase their rate of growth and these form a kind of disc round its base. The conidia are produced in large numbers from the hyphae on this disc. The epidermis remains unbroken until the conidia are ripe. Then the sterile hyphae of the central column grow until the layers of bark break. At first only a narrow opening is formed, but as the whole of the fructification grows, the slit widens and the bark is pushed outwards. Under suitable conditions of warmth and moisture the conidia are pushed out of the opening in such numbers as to be visible to the naked eye as white points.

With the canker produced by Nectria galligena and Monilia cinerea, the host plant limits the progress of the fungus by the formation of successive cork layers, not very far distant from each

other. In this case, however, the cork layer is formed at very great distances from the old ones, sometimes 5 or 6 inches, or even more. A scar may progress as much as 18 inches at a single step, although in a transverse direction it rarely exceeds $\frac{1}{2}$ inch.

The opinion of American workers appears to be that the fungus is confined to the cortex and that the damage resulting from it is negligeable. That may be so under American conditions, but in the case of the two outbreaks which have been recorded in England severe damage was being caused. It may be that the fungus becomes virulent when the trees are in a starved condition, but once it gets a firm hold on a plantation it may cause the loss of many trees. Not only the cortex is affected but a large part of the woody tissues also.

Inoculations.

The total number of inoculations made at Long Ashton amount to 50, but so far no definite signs of successful infection have resulted. The methods of inoculation have been varied so as to obtain the conditions thought to be most likely for success but without definite result. The method which gave most success was the injection of a spore suspension by means of a hypodermic syringe. These inoculations, however, are now six months old and only show very small scars about 5 mm. in diameter.

The results from these experiments support the views of the American authors that the fungus is only a weak parasite and only under exceptional conditions does it become dangerous. When these conditions are reached, however, much permanent damage is done to the trees and they may be killed outright.

Method of Infection in Nature.

Trees which are being attacked by Myxosporium corticolum are usually in a weak state and dead spurs are not infrequent. On such dead spurs the fructifications of Myxosporium corticolum have frequently been observed and it is possible that the fungus gains entrance to the tree by this means. Occasionally a fungus with a much smaller spore (9μ by 3μ) and resembling Myxosporium mali has been found on apple branches, but it is quite distinct from Myxosporium corticolum. This is interesting in view of the observations recorded by Marchal, who obtains considerable variations in the character of Fusicoccum malorum Oud in culture, especially as regards the dimensions of the perithecial necks and the grouping of the perithecia. So much so that it seems possible that several forms, Apothecia pomi, Sacc. and Schulze, and Myxosporium mali Bres are merely variations of Fusicoccum malorum Oud. Diaporthe

perniciosa hibernates on the branches of pear and apple, producing a canker in the outer layers of the bark. The bark infections give rise to numerous pycnidial stromata in the autumn, which remain hidden in the external layers, thus simulating certain species of Myxosporium.

Another method by which infection takes place is through grafting wounds. In a nursery at Sandford in Somerset a number of young standard trees were found to be infected with Myxosporium corticolum, the fungus having entered through the exposed surface of the stock, the saddle type of grafting having been used.

Occasionally also, one finds trees which had evidently become infected from the base. Usually other fungi are present in such abundance that it is impossible to identify the original parasite. Recently, however, a ten year old bush tree of the Lord Suffield variety died off very suddenly during July, and close examination of the main trunk showed typical fructifications of Myxosporium corticolum being produced in enormous numbers. The method by which the fungus entered the tree can only be conjectured, but it evidently came from the region of the ground.

CANKER INFECTION OF APPLE TREES THROUGH SCAB WOUNDS.

By S. P. Wiltshire.

In previous papers various ways in which the canker fungus enters the apple tree have been described, and in continuation of this investigation the method by which canker follows scab infection on the stems has been worked out in some detail.

The scab fungus infects the shoots of susceptible varieties of apples during the autumn and winter following their growth, the first infections usually being found before the trees defoliate. In the spring most of the pustules are surrounded by a cork layer and are subsequently completely excluded from the tree, the only trace of the infection finally being a slight roughness of the bark.

Sometimes, however, this course of events is disturbed. The cortex round the small scab pustule shows signs of blackening and this is accompanied in some cases by a swelling of the bark due to the growth of the tissue beneath the infection. Very early stages in which the discoloration is extremely slight can sometimes be identified. This difference from the normal behaviour is due to the entrance of the canker fungus, *Nectria galligena*, and the latter usually develops rapidly once it has effected an entrance. The canker infected area round the scab pustule is completely killed and blackened, usually about 5mm. in diameter, somewhat sunken and there is no crack in the bark between the healthy and diseased tissue. In the autumn and winter canker infections of scab wounds are most frequently found in this stage. Later well-defined cracks appear at the edge of the infected area and a slight swelling of the adjacent tissue takes place.

If the tree is sufficiently vigorous to form a cork layer round such a scar before the wood has become infected, the canker makes very little progress and the tree makes a good fight against the fungus. Often, however, the whole of the cortex becomes infected and the fungus reaches the woody tissues, the scar then gradually assuming the appearance of the normal canker. It is often difficult to assign any particular method of infection to a mature canker, but sometimes

specimens are found in which the concentric cracks in the bark indicate the original point of infection, which point is strongly suggestive of a scab wound. Further young stages of canker infection of scab wounds have been marked on the tree and the development of a canker observed, in a number of instances the shoot above the canker being killed off during the following summer. Fructifications of the fungus are not borne until the canker is well developed, but on keeping young infections in a moist chamber for two or three days a few small conidial pustules generally appear and afford evidence of the presence of the canker fungus.

The occurrence of this type of infection has not been found to be nearly as common as that of the leaf scar infection, but it is probably as prevalent as the infection which takes place through Woolly Aphis galls. In some years when the autumn has been specially damp, the shoots of the previous winter are often found to be killed off in large numbers. Such shoots are usually heavily infected with scab, and although they frequently bear leaf scar infections of the canker fungus, it is probably that canker infections of scab wounds are responsible for a good proportion of the damage.

For full microscopic details regarding this type of infection reference may be made to the paper published in the Annals of Applied Biology, Vol. IX., p. 275. Briefly the process is as follows. The spores of the canker fungus find their way by some means or other (possibly being carried by rain, wind or insects) onto the surface of a young scab pustule. There they germinate and the fungus hyphæ produced penetrate the scab pustule, which is confined to the outermost layers of the stem. Under favourable conditions the canker fungus may produce summer spores even at this early stage. It continues to develop and as soon as it has gained a firm hold on the scab pustule it commences to grow out into the apple stem itself, several strands of the fungus pushing their way, chiefly between the cortical cells, in a very characteristic manner. The fungus secrete some product which attacks the tissue of the stem and brings about the death of the cells. The tree usually makes some sort of attempt to stop the progress of the parasite by forming a new bark layer round the infected portion, and there are indications that sometimes it succeeds in doing so. If such a layer becomes mature before the Nectria reaches it, then it probably can progress no further unless assisted by a fresh growth of the scab fungus. Unless the new protecting bark layer is formed very rapidly, however, it is useless, for the canker fungus can pass immature layers with ease. Unless stopped by this method the fungus reaches the wood and the formation of the typical canker is only a question of time. The tissues round the infected region behave in the usual way, forming wound wood, the stem swelling up both above and below the cankered spot in the usual fashion.

The important point to the fruit grower is whether anything can be done to stop this method of infection. Of course if it were possible to control the autumn infection of young shoots by the scab fungus the task would be easy, but at present there is no known remedy against this infection. Whether spraying in autumn as soon as the fruit is off the trees would be useful or not has not hitherto been determined.

CANKER CONTROL TRIALS.

By S. P. Wiltshire.

Further spraying trials were undertaken during the season 1921-22 on the Kingston Black × Medaille d'Or seedlings in continuation of the experiments of previous years. Burgundy mixture (4:5:40) was used: 100 shoots were sprayed and 100 were protected by paper wrappers during the spraying to serve as controls. The spraying was carried out on 29th March, 1922, during fine weather, but subsequent falls of heavy snow prevented the removal of the wrappers for 3 or 4 days.

Counts were made in August, 1922, but only a total of 4 canker infections were found, all of them on control shoots. This very small percentage of infection was very disappointing and rendered the experiment valueless.

A small scale autumn spraying was carried out on eight trees of King of the Pippins variety. The object of this spraying was to prevent the entrance of the fungus through the leaf scars and was therefore applied as soon as possible after the fall of the leaves, viz., 9th November, 1921. The mixture used was Bordeaux 4 : 4 : 50, four of the trees being sprayed and four left as controls. Counts of the canker infections on 2nd March, 1922, gave for the sprayed plants, 10, 0, 12, 21—a total of 43—whilst the controls gave 21, 1, 12, 22—a total of 47. This result did not substantiate the effect of spraying obtained on the Kingston Black × Medaille d'Or seedlings in 1920. In this connection, however, it is interesting to remark the opinion expressed by American workers as to the use of autumn spraying against canker in the report of the University of California Experiment Station for 1920-21, p. 55. "Dr. Zeller of the Oregon Station reports that, from present indications, the treatment for Northwestern canker (*Neofabraea malicortis*) Bordeaux 6 : 5 : 20 after the fruit is off and again in three weeks, may also control the European canker (*Nectria galligena, Bres.*)" An autumn spraying against canker may not be so effective as to make it economically sound.

THE PHYSIOLOGY OF LEAF SCORCH.

By F. Summers.

The problem of the cause of Leaf Scorch, or Tip Burn as the trouble is termed in the United States, has recently received considerable attention in an endeavour to discover an ameliorative treatment of a source of serious loss in the garden, orchard and plantation.

The various agents supposed to be responsible have been investigated and classified by Barker and his co-workers at the Long Ashton Research Station, who carried out most of their observations on fruit trees (i), and in the United States by Lutman, Neller and Morse who studied the trouble in the potato (ii, iii and iv).

The conditions under which Scorch might appear were in many cases found to be connected with conditions in the soil, such as inadequate aeration, inferior water-holding capacity, lack of available potash, or the presence in toxic proportions of chemical substances such as lithium carbonate and borax which do not, however, usually occur in such proportions.

All the above conditions were found to make for restricted root-development or action, although the root-development effect was not actually separated from that due to poverty in water.

The trouble was also found in association with special atmospheric conditions, such as the prevalence of drying winds during periods of intense solar illumination or conditions of excessive local heating of the leaves by the sun. Lutman (iii) also demonstrated the destructive action of intense sunlight upon the green colouring matter of the potato leaf.

Other factors of minor importance or less common occurrence were studied, such as interference with the water supply system by ringing and the action of the spray from sea-water (v).

(i)—Barker, B. T. P., Lees, A. H., Wallace, T., and Wiltshire, S. P. Ann. Rep. Agric. and Hort. Res. Sta., Long Ashton, Bristol. 1921.

(ii)—Lutman, B. F. Vermont Agric. Exp. Sta., Bulletin 214, 1919.

(iii)—Lutman, B. F. Phytopathology. Vol. 12, 5, 1922.

(iv)—Neller, J. R. and Morse, W. J. Soil Science. Vol. 12. 1921.

(v)—Boodle, L. Journ. Min. of Agriculture. 1920.

Although no complete explanation of the cause of Leaf Scorch has up to the present been formulated, certain theories have been put forward. These are based upon some or all of the following underlying disorders :—

(1) Excessive loss of water by transpiration from the leaves.

(2) Heating or illumination of the green chloroplasts of the leaf to a point above the normal.

(3) The accumulation of toxic substances in the leaf and an accompanying restriction of root-development.

(4) A lack of balance, either in degree of development or in activity, between the root and shoot portions of the plant, the root generally being incapable of supplying the water requirements of the leaves under conditions which favour a high rate of transpiration of water from the latter.

The first sign of Scorch is a yellowing of the leaf in patches, which, as a rule, appear earliest near the margins or tips. Under very severe conditions the patches may be distributed over the whole surface of the leaf. This yellowing is succeeded by a browning of the patches which generally assume a dark-brown, burnt appearance and this is the stage which is usually first noticed in the plantation. A certain amount of perplexity has however been caused, especially to the grower, when this browning has been observed to occur in cool, moist weather, *i.e.*, under conditions just the opposite of of those which are regarded as productive of Scorch. The explanation is a simple one as will be seen in the sequel.

Seeing that the suspected casual factors are so many and varied and that a complete explanation of the causes of Scorch was not available it was considered worth while to examine the extent to which the physiological processes of the plant might be affected under " scorching " conditions.

Transpiration under Scorching Conditions.

The first process to be examined was that of transpiration, the normal process by which the leaves give off the excess of water above the immediate requirements of the plant.

It must not be supposed that it is possible always, in the complete living plant, to isolate for detached study a function such as transpiration. Where a physiological process can be studied separately it has been shown, *e.g.*, by Matthaei (vi) for the carbon-assimilation of the leaf, that when a factor, *e.g.*, temperature, is

(vi)—*Matthei, G. L. C. Roy. Soc. Phil. Trans., B.*197, 1904.

increased the rate may be increased only up to a certain point for the process is limited by the slowest factor, *e.g.*, the supply of carbon-dioxide.

Further, Matthaei also showed for the assimilation process that the rate at a high temperature is maintained at its highest level for a short time only and then falls off rapidly.

In the living plant under natural conditions all the various physiological activities are mutually interdependent, and the attempt should be to discover the individual process which is limiting the activity of the plant as a whole rather than an attempt to evaluate the factor which is limiting one process. For example, the atmosphere may be saturated with moisture to such an extent as to cause the stomata of the leaf to close during a period when the illumination is appropriate for increased assimilation and, as transpiration is affected by humidity to a greater extent than by light, the leaves may be left to do the best they can for themselves so far as the taking in of carbon-dioxide is concerned.

As ordinarily understood the transpiration of water vapour from the leaf is regulated by the guard cells of the stomata. There is, in addition, to be considered the loss of water by ordinary evaporation from the cuticle and pores of the leaf. Under ordinary conditions this is small but, when intense solar illumination is combined with extreme dryness of the atmosphere, it may become very considerable.

It is also necessary to consider, not only the loss of water from the leaf, but the process by which this is replenished by the ascending water current. This, in turn, is dependent upon the process of water-absorption in the root-system.

Normally these three part-processes are correlated, the result being a steady condition of things which may however be rudely disturbed if one of the part-processes is drastically modified. For example, if a young apple shoot is girdled with a wide ring and the bare surface exposed to drying conditions, the upward flow of water may be interfered with to such an extent that the leaves above the ring will be insufficiently supplied. Thereupon either wilting or scorch of these will follow according to the severity of the external conditions.

Another consideration to be taken account of is that the term excessive transpiration is often loosely employed to describe what is taking place in a set of conditions which have already brought the process to a halt.

The work performed during the transpiration of water vapour is due to the direct conversion of heat energy absorbed by the leaf so that a cooling effect on the latter is present as long as the process is proceeding normally. This can only be the case if the temperature of the leaf is at least slightly higher than that of the surrounding

atmosphere whatever be the humidity of the latter. Should the atmosphere be hot and dry and above the temperature of the leaf then the stomata cease to regulate the loss of water which becomes vapourised by ordinary evaporation owing to the excess of heat energy absorbed. Complications no doubt arise as the concentration of the sap is gradually increased, but the end result is a drying out of the leaf. During the earliest stages of this the shrinkage of the epidermis tends to keep the stomata open and encourage the loss of water from their cavities.

It is evident, therefore, that in spite of any increase in the activity of the root or of the water-conducting system, the system as a whole will experience a breakdown when the evaporation from the leaf becomes excessive. Experiments showed this to be the case under scorching conditions of the atmosphere.

Lutman found that specially large water pores were present near the margins and tips of potato leaves and that scorch made its first appearance near to these (iii).

In the foregoing no account has been taken of the effect due to intense illumination. Ultimately this has a destructive action upon the chlorophyll of the leaf, especially when this is thinly distributed, but the response of transpiration to light is but small compared with its response to a low degree of humidity of the atmosphere. Within limits the internal temperature of the leaf increases with the intensity of illumination, as Blackman and Matthaei have shown (vii), and the resulting increase of energy is doubtless largely converted into work in the transpiration process.

Any factor which tends to increase the rate of evaporation from the leaf assists in producing scorching conditions. A factor of this kind is wind or air movement. In still air "shells" of water vapour are formed over the surface of the leaf and these tend to keep down the rate of evaporation from it. The effect of wind movement has been closely studied but it is possible to say nothing more definite than that, when moving parallel to the surface of the leaf, the wind removes these "shells" of water vapour and increases the rate of evaporation. Under natural conditions, however, the wind is changing constantly both in direction and intensity with respect to any given leaf.

As bearing on the question of the earliest appearance of scorch at the margins of the leaves it is of interest to note that, when a leaf is placed at right angles to the direction of the wind, the stream-lines and eddies are so produced as to remove the water vapour most rapidly from the marginal area. Over the middle portions of the leaf area are produced a region of positive pressure on the windward side and of negative pressure on the lee side. On the windward

(vii)—Blackman, F. F. and Matthaei, G. L. C. Roy. Soc. Proc., B. 76, 1905.

side, therefore, there is a tendency for the evaporation from the middle region to be depressed and to be increased from the corresponding area on the leeward side. At the margins, however, the rate is greatly increased.

Interference with the Water Supply to the Leaf.

Barker and his colleagues repeated with apple leaves Haberlandt's experiment with those of the sycamore and other trees (viii). In this one or more veins were severed, the other tissues of the leaves being uninjured. Like Haberlandt, they found that leaves treated in this manner might continue to function normally for weeks with no sign either of wilt or scorch, although they point out that the atmospheric conditions during the experiment did not favour rapid transpiration. Lutman also repeated this experiment with leaflets of the potato and found that nothing happened in four days, although "the sunshine had been brilliant and the temperature high."

Under ordinary conditions, therefore, it appears as though the translocation of water from cell to cell in the leaf were sufficiently rapid to make good the loss due to transpiration even when the more rapidly conducting path of supply through the veins is interrupted.

Interference with the water supply is produced when the shoot is ringed. During the past summer experiments were carried out on apple shoots which, after being ringed, were placed in position in a specially constructed potometer by means of which the quantity of water taken up by the shoot in a given time could be accurately measured. The rate of evaporation from the surface of the ring could be increased by regulating a blast of hot air at right angles to it. It was possible to increase the rate of loss of water from the ring to such an extent as almost entirely to cut off the supply to the portion of the shoot above it. When the experiment was carried out in a cool room with a north aspect wilting of the leaves invariably followed when this stage was reached.

Similar experiments were carried out in a greenhouse in which the shade temperature was often 80°F. and the humidity generally below 50 p.c. of saturation. In unringed shoots the upper leaves began to show patches of yellow on the third day, while the rate of absorption of water and of transpiration by the shoot gradually diminished. The leaves continued to dry out until only small, narrow, turgid, green areas near the bases of the main veins remained to maintain a feeble rate of transpiration. If these areas were vaselined the shoot ceased to absorb water to any noticeable extent. In the case of ringed shoots the leaves above the ring were scorched

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(viii)—Haberlandt, G. Physiologische Pflanzenanatomie. 4th Ed. Leipzig.

badly on the second day. There was no intermediate wilting stage and the leaves below the ring continued to transpire for at least two days longer before showing signs of scorch.

More striking and rapid results were obtained when an unringed shoot was supplied with a 5 per cent. or 10 per cent. solution of cane sugar in place of water under the above conditions. The rate of water uptake declined rapidly to a very low value while the leaves were scorched very badly on the second day. Actual browning of the patches did not occur, however, before the night of the third day on which the humidity had been greater and the illumination much less than on the preceding two days.

Controls set up in water by the side of the potometer showed signs of wilting on the second day but no scorch appeared ; other shoots set up in a cool north room showed no sign either of wilting or scorch. A control shoot set up by the potometer but supplied with no water behaved differently for its leaves dried out quickly without passing through an intermediate stage of wilt. On the fourth day the light green colour of the dessicated leaves was replaced by the typical browning of scorch.

Estimations of the quantity of sugar solution taken up by one of the experimental shoots showed this to be about 40 per cent. of the wet weight. This was approximately the same percentage of the wet weight that could be dried out of a similar shoot by leaving this exposed to bright sunlight for several hours in the greenhouse. The probability is, therefore, that the solution was able to penetrate the shoots only to the extent of replacing the water already present in the conducting system after this had been lost during the transpiration process. At this point the process broke down suddenly, owing, no doubt, to the inability of the solution to enter the cells of the leaf rapidly enough to maintain it. Under the conditions prevailing in the greenhouse these cells thereupon dried out rapidly.

The Relation Between Scorch and Wilt.

It has been shown above that wilting is not necessarily an intermediate stage of scorch. There are obvious differences between a wilted leaf and one in a state of incipient scorch. The wilted leaf is flaccid owing to loss of turgidity and its petiole is curved, drooping and flaccid from the same cause. Such a leaf may recover its turgidity under conditions which make for reduced transpiration, while under conditions of extreme heat, dryness and illumination it will gradually dry out without ever recovering.

In the case of the scorched leaf the evaporation pull on the water of the leaf has not only been severe but also sudden. Then the lamina of the leaf does not become flaccid but more or less completely dessicated in a very short time. It is then light enough

to be carried at its original angle to the shoot by the totally dessicated and shrunken petiole. The rigidity of the latter is sufficient to prevent any preliminary stage of droop.

Knight has shown that at the beginning of wilting there is a preliminary rise in the rate of transpiration accompanied by opening of the stomata (ix).

This temporary increase did not occur in the potometer experiments, and, in all probability, represents a phase which is omitted by the scorched leaf. A discontinuity takes place abruptly in scorching conditions owing to the water of the leaf being withdrawn so rapidly that the replacement water is unable to maintain the connection so as to make good the loss. The leaf and petiole thereupon dry out quickly, the rigidity of the dessicated skeletal portions being sufficient to maintain the original angle of inclination.

Lutman appears to be of opinion that a reversible wilt, accompanied by partial plasmolysis and yellowing of the colour bodies, can pass into an irreversible fatal condition if the exposure to hot sunlight is prolonged. If the exposure is curtailed he considers that the plasmolysed cells may recover their turgidity but not their greenness.

In a few cases yellowed patches of apple leaves have been observed to retain their turgidity for many days when transferred to a cool room, but the cells of these certainly were not plasmolysed when so transferred. The yellowing is best regarded as a stage in the process of scorching, for some of it is merely optical and due to the drying out of the leaf tissue.

The Relation of the Potash of the Soil to Leaf Scorch.

Apart from the effect of soil texture upon the development of the root, work on leaf-scorch soils has shown very clearly the existence of a correlation between a low content of available potash and the production of scorched foliage. Deficiency of phosphoric acid appears also to play a definite, if subsidiary, rôle.

The literature of plant physiology contains numerous works upon the relation of potash to growth and development. In one of the latest of these Smith and Butler (x) have shown that in wheat, barley and buckwheat one effect of a deficiency of potash may be the withering or browning of the leaf tip. But very little work has been done on the question of the modification of individual processes when potassium is absent. Briggs has lately published the results of an investigation of the effect of potassium, phosphorus or calcium starvation upon the carbon-assimilation process. He

(ix)—Knight, R. C. Annals of Botany, XXXV., 1921.

(x)—Smith, T. O. and Butler, O. Annals of Botany, XXXV., 1921.

found that assimilation was below normal when the supply of either of these essential elements was deficient (xi).

Up to the present attention has been chiefly directed to the general response, in pot experiments, to potassium starvation. The consequence is that there appears to exist no relation whatever between the two sets of conditions, of soil and atmosphere respectively, which have been proved to produce scorched foliage. The possibility of one or more plant processes being below normal in conditions of potassium starvation opens up a new line of enquiry which should soon lead to the connection between the two sets of conditions being established.

The Pigments and Enzymes of the Leaf.

The yellowing or first appearance of scorch is due partly to the drying out of the leaf tissue and partly to the destruction of the green and yellow pigments by certain enzymes, or ferments, of the leaf which have the power to oxidise them. The first stage to be noticed in the plantation is, as has already been mentioned, the subsequent browning of the scorched patches.

The following is a brief summary, in general terms, of the chemical changes in the leaf which result in the production of these colours. There are present in the leaf colour-producing bodies or chromogens, which increase greatly in quantity in bright sunlight, in solutions of cane sugar or, whent he rate of respiration of the leaf tissue is increased as it is on drying out. These chromogens are acted upon by certain of the oxidising enzymes mentioned above to form pigments such as those responsible for the browning. The enzymes are unable to act, however, if the leaf tissue is quite dried out. Should it absorb moisture subsequently the action may recommence and the pigments be formed.

When apple leaves were dried out at a moderate temperature in the oven they did not become brown but retained a greenish colour for weeks. If, however, these dried leaves were soaked in water for one hour and again laid out to dry browning quickly followed. This was always more intense round the edges of cuts or perforations in the leaves where the water had penetrated to a greater extent. Soaking is not essential, however, for if the dried leaves were laid out in a moist atmosphere the browning took place.

If the dried leaves were dipped into boiling water or were suspended in steam for a few minutes before being laid out to dry again no browning occurred owing to the destruction of the enzymes.

Under natural conditions leaves which have become dried out during a sunny day may absorb sufficient moisture to permit enzyme action to proceed. If rain or moist atmospheric conditions follow

(xi) Briggs, G. E. Roy. Soc. Proc., B.94. 1922.

on the drying out, browning takes place more rapidly and as, in all probability, the previous stage has passed unnoticed this easily accounts for reports of the occurrence of scorch when the atmospheric conditions are not those which are generally held to be responsible for the trouble.

Summary and Conclusions.

(1).—The characteristic "browning" of leaves suffering from scorch is an after-effect which may make its appearance after the conditions responsible for the scorching have passed. The real primary effect is characterised by more or less complete destruction of the green pigments of the leaf combined with a drying out of the cells.

(2).—The "browning" is, in all probability, due to the action of oxidising enzymes upon the chromogens or colour-producing bodies produced during the drying out of the leaves. This action does not take place in the dried leaf but commences as soon as this re-absorbs moisture from the air.

(3).—Drying out of the leaf is caused by a sudden discontinuity in the transpiration stream. There is, generally, no intermediate wilting stage. The discontinuity arises in the leaf not in the conducting system of the shoot.

(4).—While it has been shown that potash starvation may lead to scorching of the foliage, the relation of potash deficiency in the soil to the water relations in the transpiring shoot needs further study. The fact that it has been proved that the photosynthetic process in the leaf is depressed when potash is withheld leads to the conclusion that this relation will soon be established.

EXPERIMENTS ON CHLOROSIS—WITH SPECIAL REFERENCE TO CASES AT WINSCOMBE, SOMERSET.

By T. Wallace.

Introduction.

The term "chlorosis" is generally applied to any abnormal condition in plants in which one of the most conspicuous symptoms is a lack of green pigment. The foliage of such plants is generally of a pale yellowish green colour and in cases of acute chlorosis the green colour may be almost entirely absent. Chlorotic plants generally make poor growth and their cropping powers are generally seriously affected by the condition.

"Chlorosis" is recognised as being distinct from "variegation" in plants, which latter is generally considered as being an inherited tendency of certain varieties of plants to grow parts of their foliage lacking in chlorophyll, and which is not usually considered as being pathological.

True chlorosis, according to several workers on the subject, may be produced by a number of causes, such as low temperatures, lack of nitrates in the food of the plants, very bright sunlight, deficiency in water supply, etc.

It is also common knowledge that many plants generally develop chlorosis on calcareous soils, whilst a chlorosis of pineapple plants has been associated with high manganese content in certain soils in Hawaii, and recently a chlorosis of tobacco plants on certain soils in North Carolina has been shown to be due to a deficiency of magnesium in the soils.*

The experiments described in this paper were carried out on two samples of soil derived from the Dolomitic Conglomerate area at Winscombe, Somerset.

One of the samples was taken from an old garden which had been highly manured and the other from a heap used as "potting" soil, which had been collected from the hillside near the garden. The latter is typical of the soil of the hill pastures of the area.

*Journal of Agric. Research, Vol. XXIII, No. 1, Jan. 1923.—Sand Drown, a Chlorosis of Tobacco due to Magnesium Deficiency and the Relation of Sulphates and Chlorides of Potassium to the Disease.

It was stated that most garden and hot-house plants, when grown in either of these soils, made very poor growth and almost always showed symptoms of chlorosis.

Attempts had been made to remedy this condition by applying dressings of farmyard manure and of fertilisers containing nitrogen, potash and phosphoric acid, but without effect.

Soil samples for examination were obtained during the summer of 1920, and the work carried out on these is described in the Annual Report of this Station for 1920.

It was shown then that both soils contained high percentages of magnesium and calcium compounds, and that whilst the garden soil contained a large amount of carbonates, the potting soil contained only a normal amount—less than 1% reckoned as calcium carbonate.

Some preliminary experiments were carried out during the autumn of that year in which mustard and tomato plants were grown in the soils and in these experiments only the tomato plants grown in the pots containing the garden soil developed chlorosis. In these experiments the soil in some of the pots was sterilised previous to the planting operations, but this treatment did not appear to affect in any way the amount of chlorosis developed.

As the above experiments had been carried out during the latter part of the growing season, and as all the plants had made rather poor growth, it was decided to repeat the experiment, with the exception of the soil sterilisation treatment, in 1921, when other experiments were to be carried out.

1921 Experiments.

Two series of experiments were carried out during this season and for these fresh samples of soil were obtained. Analytical data on these samples are given in Table I.

TABLE I.

Soil Data of Samples used in 1921 Experiment.

	Potting Soil. %	Garden Soil. %
Stones in sample	Nil	12·0
Moisture	4·56	3·80
Loss on Ignition	13·36	11·80
Total Potash (K_2O)	1·60	0·972
Total Phosphoric Acid (P_2O_5) ..	0·141	0·345
Available Potash (K_2O)	0·0247	0·0639
Available Phosphoric Acid (P_2O_5) ..	0·0161	0·0307
Carbonates (as $CaCO_3$)	0·78	14·90
*Calcium Oxide (CaO)	1·29	5·58
*Magnesium Oxide (MgO)	2·24	3·87
†pH value	7·22	7·10

* Soluble in concentrated Hydrochloric Acid.

† Kindly determined by Mr. E. M. Crowther, Rothamsted Experimental Station.

The first series of experiments was designed to test the following points :—

Experiment 1.—Whether tomato plants—which were known to be susceptible—became chlorotic when grown in samples of garden soil and of potting soil.

Experiment 2.—Whether the chlorotic condition produced could be remedied by spraying the foliage of the affected plants with a solution of ferrous sulphate of suitable strength.*

Experiment 3.—Whether tomato plants grown in samples of Research Station potting soil, mixed with amounts of calcium carbonate, so that the resultant samples contained amounts of carbonates equal to those in the garden soil and potting soil respectively would become chlorotic.

As a preliminary to Experiment 2, it was proposed to raise a batch of tomato plants with which to carry out spraying trials with ferrous sulphate solutions of various strengths in order to discover the best strength of solution to use in the experiment. Unfortunately the number of plants available for this purpose was small and as serious injury to the foliage resulted from all the concentrations tested—concentrations from 1·0% to 0·1% were tried—this experiment was abandoned.

Experiments 1 *and* 3.—For purposes of presentation it is convenient to describe experiments 1 and 3 together. In these two experiments tomato plants—three plants per pot—were grown in plant pots of 10in. diameter—Nos. 1 to 12 below—containing samples of soil as under :—

Pot No. 1 contained 7 kilograms of untreated garden soil.

Pots Nos. 2 *and* 3 each contained 7 kilograms of garden soil from which the stones had been removed by sieving.

Pots Nos. 4, 5 *and* 6 each contained 7 kilograms of untreated potting soil.

Pots Nos. 7, 8 *and* 9 each contained 7 kilograms of untreated Research Station potting soil.

Pots Nos. 10, 11 *and* 12 each contained 7 kilograms of " treated " Research Station potting soil. The " treated " soil had been prepared by mixing the original Research Station potting soil with the calculated amount of precipitated calcium carbonate to bring the content of carbonates up to that contained in the garden soil.

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* *Journal of Agric. Research*, Vol. XXI., No. 3, May 2nd, 1921.—A Chlorosis of Conifers Corrected by Spraying with Ferrous Sulphate.

Pots Nos. 13, 14 *and* 15 each contained 7 kilograms of "treated" Research Station potting soil. Here the treatment consisted of mixing the soil with precipitated calcium carbonate to bring the content of carbonates up to that contained in the potting soil.

Notes.—

(1) The original sample of Research Station potting soil contained no carbonates and showed a "lime requirement" of 0·425% by the Hutchinson-McClennan method.

(2) The mixing of the soil with calcium carbonate was carried out about one month before the plants were planted and during that time the prepared soils were kept in a moist condition.

The plants were transferred to the respective pots on May 14th, and during the period of treatment they received only normal watering with tap water.

Early in June the plants in certain of the pots developed chlorosis, and the condition of the plants in the various pots, as observed on June 25th, is given below.

Observations made on June 25th.

Pots Nos. 1, 2 *and* 3—*Garden Soil.* The plants in all pots were stunted and had small leaves. They were all badly affected with chlorosis.

Pots Nos. 4, 5 *and* 6.—*Potting Soil.* The plants in all pots had made poor growth, but were better than those in the garden soil. They were all chlorotic, but to a much less extent than those in Pots Nos. 1, 2 and 3.

Pots Nos. 7, 8 *and* 9—*Untreated Research Station Potting Soil.* These plants had made poor growth and their foliage showed purplish tints. There was no chlorosis present. The plants were probably suffering from the effects of the acid soil.

Pots Nos. 10, 11 *and* 12—*Research Station Potting Soil* + 14·9% *CaCO* (*i.e., similar to Garden Soil*). The plants had made fairly good growth, but there was a small amount of chlorosis present—much less than in Pots Nos. 1—6.

Pots Nos. 13, 14 *and* 15.—*Research Station Potting Soil* + 0·8% $CaCO_3$ (*i.e., similar to Potting Soil*). The plants had made good growth and were entirely free from chlorosis.

During July the plants in Pots Nos. 10, 11 and 12 became more chlorotic, but they were never so badly affected as those in Pots 1—6.

Towards the end of July and during August it was observed that the plants in Pots Nos. 4–6 began to make better growth and the new foliage produced was less chlorotic than the old.

The second series of experiments was commenced on July 22nd

with the object of studying the effects produced on the growth of tomato plants by applying certain dressings of magnesium carbonate and of calcium carbonate to the Research Station Potting Soil.

The plants were grown in plant pots of 10in. diameter, as in the previous experiments, and the different soil treatments were as under.

A bulk of Research Station potting soil was mixed with the amount of precipitated calcium carbonate, calculated to neutralise its acidity, and samples from this prepared soil, treated as follows, were placed in the pots.

The weight of mixed soil used per pot was 7 kilograms. The final mixings, as in the previous experiment, were carried out a few weeks previous to planting. Precipitated magnesium carbonate was used in all cases where this compound was added.

Pot No. 1 contained prepared soil + calcium carbonate to bring calcium carbonate content up to 0·8%.

Pot No. 2 contained prepared soil + magnesium carbonate to bring magnesium carbonate content up to 0·8%.

Pot No. 3 contained prepared soil + magnesium carbonate to bring magnesium carbonate content up to 0·67% (*i.e.*, content of carbonate equivalent to Pot No. 1).

Pot No. 4 contained prepared soil + magnesium carbonate to bring magnesium carbonate content up to 0·67% + calcium carbonate to bring total carbonates up to equivalent of 14·9% calcium carbonate.

The late planting of these plants again prevented satisfactory growth being made before the close of the season and although all the plants looked very unhealthy—the foliage having a purplish tint and the leaflets being curled back towards their under surfaces, none of them showed any symptoms of chlorosis, and it was decided to repeat the experiment in 1922, which latter experiment is described below.

1922 Experiments.

During this season, in addition to repeating the experiment described above, an experiment was carried out to ascertain whether the addition of progressive amounts of calcium carbonate to the potting soil would render plants grown in the soils more chlorotic. For purposes of comparison, plants were also grown in samples of the garden soil. The soils used in this experiment were the same as were used in the experiments in 1921. They had been turned out of the pots after the completion of the 1921 experiments and kept in a dry state under cover during the winter.

The plants used in both experiments were tomato plants—variety, Kondine Red—two per pot being planted.

They were transferred to the pots on May 22nd, and received normal watering during the period of the experiments.

The condition of the plants in the two experiments on certain dates is given below.

Experiment with Magnesium Carbonate.

Date of Observation.	Pot No. 1.	Pot No. 2.	Pot No. 3.	Pot. No. 4
June 30th ..	Colour of foliage normal. Growth only poor.	Colour of foliage normal. Only one plant making good growth.	Colour of foliage normal, being similar to No. 2.	Foliage slightly paler than in other pots.
July 11th ..	Ditto.	Ditto.	Ditto.	Foliage distinctly chlorotic.
Aug. 1st ..	Ditto.	Foliage slightly pale. Lower leaves of plants dying.	Foliage slightly pale.	Ditto. Lower leaves dying.
Aug. 12th.. ..	Ditto.	Foliage was slightly chlorotic and plants were unhealthy.	One plant fairly normal. Foliage of other slightly chlorotic.	Plants chlorotic.
Aug. 25th.. ..	Foliage slightly pale and plants unhealthy.	Similar to plants in Pot No. 1.	Similar to Plants in Pot No. 1.	Plants chlorotic and condition very poor.

Experiment with Potting Soil.

Date of Observation.	Potting Soil Untreated.	Potting Soil + 5% $CaCO_3$	Potting Soil + 10% $CaCO_3$	Garden Soil Untreated.
June 30th ..	Foliage slightly paler than normal. Growth fairly good.	Similar untreated.	Similar untreated.	Foliage all chlorotic and lower leaves dying off. Plants stunted.
July 11th ..	Foliage slightly chlorotic.	Foliage slightly chlorotic.	Foliage slightly chlorotic.	Ditto.
July 17th ..	Foliage slightly chlorotic. Growth fairly good.	Foliage more chlorotic than untreated soil.	Foliage more chlorotic than 5% treatment but less than in garden soil.	All plants chlorotic and lower leaves dying off. Growth very poor.
Aug. 12th ..	Plants chlorotic.	Plants more chlorotic than untreated.	Plants slightly more chlorotic than 5% treatment.	Plants very markedly chlorotic and growth very poor.
Aug. 25th ..	Ditto. Growth poor.	Ditto.	Plants very markedly chlorotic.	Ditto.

Discussion of Results.

Soil Data.

From the data given in Table I it will be seen that the percentages of magnesium oxide (MgO) and calcium oxide (CaO) are high and that whilst in the potting soil the ratio $\frac{MgO}{CaO}$ is greater than unity, the ratio $\frac{MgO}{CaO}$ is less than unity in the garden soil. Further, the amounts of calcium and magnesium compounds present are greater in the garden soil than in the potting soil.

The pH values show that both soils are practically neutral in reaction, which is rather surprising in the case of the garden soil, in view of the large percentage of carbonates present in this soil.

1920 *Experiments.*

1.—Mustard plants did not develop chlorosis in either soil.

2.—Where tomato plants were planted late in the season no chlorosis was observed on the plants growing in the potting soil, whilst those growing in the garden soil were not badly affected.

3.—Previous sterilisation of the garden soil did not appear to affect the amount of chlorosis developed on tomato plants, although the growth of the plants was improved by the treatment.

1921 *Experiments.*

Series I.

1.—Spraying the foliage of tomato plants with ferrous sulphate solutions of strengths between 1·0% and 0·1% produced very serious injury to the foliage, the plants being practically killed after three to five applications over a period of 10 to 14 days.

2.—Tomato plants, planted in May, made very poor growth in both the garden soil and the potting soil. The leaflets of the plants were very small and in both soils the plants were chlorotic. The chlorosis developed in the plants grown in the garden soil was much more severe than that in the plants grown in the potting soil.

3.—Towards the end of July, and during August, the new foliage produced by the plants in the potting soil was much less chlorotic than that produced before that time.

4.—Plants grown in Research Station potting soil, containing 14·9% of calcium carbonate, were slightly chlorotic—much less so than those grown in the potting soil or garden soil, whilst those grown in the Research Station potting soil containing 0·8% of calcium carbonate, did not develop any visible signs of chlorosis.

Series II.

1.—Here also where plants were planted late in the season no chlorosis was developed, whilst where planting was carried out in these soils early in the season in 1922, chlorosis was developed.

1922 *Experiments.*

(*a*) *Experiment with Research Station Potting Soil.*

1.—Where 0·8% of calcium carbonate was added to the soil the foliage was slightly paler than normal towards the end of August. Plants grown in this soil under the same conditions of experiment in 1921 did not develop chlorosis throughout the experiment.

2.—Plants grown in the soils to which 0·8% magnesium carbonate and 0·67% magnesium carbonate respectively had been added developed slight chlorosis, and the older foliage died off prematurely.

Where 0·67% of magnesium carbonate + calcium carbonate to bring total carbonates in the soil up to 14·9% was added to the soil, the plants made very bad growth and were highly chlorotic.

(*b*) *Experiment on Effect of Adding Calcium Carbonate to The Potting Soil.*

Plants grown in samples of the potting soil, to which 5% and 10% of calcium carbonate respectively had been added, developed chlorosis to a greater extent than those grown in the untreated potting soil. Those grown in the soil containing 10% calcium carbonate were slightly more chlorotic than those grown in that containing 5% of that substance.

Summary of Results.

The chief points brought out by the experiments described are as follows :—

1.—The soils contain large supplies of compounds of magnesium and calcium, the amounts of each being greater in the garden soil than in the potting soil. The percentage of total carbonates present in the garden soil is high.

2.—Plants became more chlorotic when grown in the garden soil than in the potting soil.

3.—Plants were more chlorotic when grown in samples of potting soil, to which amounts of calcium carbonate had been added, than were those grown in untreated potting soil.

4.—When samples of Research Station potting soil were mixed with certain quantities of magnesium carbonate and calcium carbonate and tomato plants grown in them, the plants developed chlorosis.

5.—There were three cases in which it was observed that plants growing in autumn did not develop chlorosis to the same extent as when growing in summer. A similar observation is recorded by Sachs.*

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* 1888. Arb. Bot. Inst., Würzburg, Bd. 3, Heft 4, p. 433—458.

6.—Spraying with ferrous sulphate solutions of concentrations from 1·0% to 0·1% caused serious injury to the foliage of tomato plants in all cases.

Conclusions.

1.—Chlorosis of plants grown in these soils is associated with high contents of calcium and magnesium compounds in the soils and is probably caused by the action of these compounds in the soils.

2.—The addition of calcium carbonate to the potting soil results in the plants growing in it exhibiting more pronounced symptoms of chlorosis.

3.—Chlorosis of plants grown in these soils is not associated with a highly alkaline reaction of the soils, as shown by pH determinations.

4.—The addition of certain quantities of calcium carbonate or of magnesium carbonate to a soil in which plants do not normally develop chlorosis may cause plants grown in it to become chlorotic.

5.—Plants become chlorotic more readily under summer conditions than under autumn conditions.

CIDER-MAKING EXPERIMENTS WITH CULINARY AND DESSERT APPLES.

By B. T. P. Barker and Otto Grove.

It has been evident during the past few years, from the number of enquiries received by the Institute, that the use of dessert and culinary apples for cider-making is being considered to an increasing extent by fruit-growers in this country, and that information as to their suitability for the purpose and the right lines of procedure is desired. The reasons for this development have been indicated in various articles previously published and need not be recapitulated here: it is sufficient to state that it has arisen in all countries where the production of table apples has reached the point where some form of profitable utilisation of the lower grades of this class of fruit other than for eating purposes has become a definite economic problem. It is not a new proposition, for cider has been made from such fruit for many years, particularly in North America. In a general way its limitations for the purpose are already familiar to the cider industry and further investigation is hardly needed to establish the point of its inferiority to vintage fruit proper or the directions in which it falls short in vintage quality. At the same time very little in the way of detailed information has been published, and advice is being constantly sought as to methods of use and treatment to give the best results. For that reason, considerable attention has been given at Long Ashton recently to the use of such fruit for cider-making, and the results seem worth putting on record for the benefit of those to whom the subject is relatively new, although as a contribution to knowledge they serve only to confirm what has been learnt by past experience in the industry.

The Composition of the Juice of Market Varieties of Apples.

The Annual Report of the Institute for 1909 contains the results of analyses of the juices of several varieties of table apples, which

show that as a class in comparison with vintage fruit, the specific gravity of the juice—and therefore its sugar content—is low and its potential alcoholic strength accordingly low also, the acidity high, "tannin" low, and rate of fermentation high. Colour generally is very pale. These features indicate that cider made exclusively from such fruit will lack body, be markedly acid in flavour, difficult to produce with any considerable degree of natural sweetness, and in some respects deficient in keeping quality. The following table of analyses of the juices of some of the better-known commercial varieties further illustrates these features of composition. It contains the analyses of the juices of the sorts named, in all cases except Bramley's Seedling and Lane's Prince Albert the fruit being of the 1922 crop. The results for the two sorts named were obtained from fruit of the 1921 crop, which for apples generally contained an unusually high percentage of sugar. The amount of sugar is indicated approximately by the specific gravity, 1.050 representing about 10 per cent of sugar and every 4 points difference roughly 1 per cent. The rate of fermentation quoted is the number of points of specific gravity lost on an average in 24 hours when the juice is kept at 25°C. For comparison the composition of a typical vintage variety of high quality, Kingston Black, is also included.

Name of Variety.	*Specific Gravity.*	*Acid %*	*Tannin %*	*Rate of Fermentation.*
Dessert—				
Allington Pippin	1·044	·67	·10	13·
Coronation	1·047	·34	·05	14·
Cox's Orange Pippin	1·057	·59	·09	6·3
James Grieve	1·045	·69	·05	9·
Rival	1·046	·63	·06	7·
Wealthy	1·045	·81	·06	8·6
Worcester Pearmain	1·047	·28	·11	10·
Culinary—				
Bismarck	1·040	·97	·11	11·
Bramley's Seedling	1·050	1·01	·14	12·
Grenadier	1·044	1·09	·08	8·6
Lane's Prince Albert	1·052	1·06	·10	12·3
Lord Derby	1·041	·51	·03	12·6
Newton Wonder	1·042	·57	·09	9·6
Potts' Seedling	1·042	·66	·06	8·4
Royal Jubilee	1·047	·52	·08	14·
Warner's King	1·041	·89	·08	9·3
Vintage—				
Kingston Black	1·060	·5	·2	3·

Of the varieties included in this table there are only three—Cox's Orange Pippin, Coronation and Worcester Pearmain—which would

yield ciders materially different in character from the type commonly produced from the table fruit. The analyses show that the remainder would give ciders deficient in body and colour, relatively coarse in flavour and lacking in fruity character, and with degrees of acidity ranging from moderate briskness (in the case of Lord Derby) to excessive sourness (in the case of Grenadier). The fermentation in nearly every instance would require close attention and be more or less difficult to control. Two of the three exceptions—Coronation and Worcester Pearmain—differ from these only in degree of acidity. Their acid content is so low that they may be grouped definitely with the "sweet" class of apples. Ciders made from them, therefore, will tend to be insipid and lacking in briskness. The third exception—Cox's Orange Pippin—stands quite apart from the rest in type. The sugar content of the juice is up to a very fair vintage standard, the acidity is of the desired standard, and the rate of fermentation is sufficiently low to permit of easy control and the retention of fruity character. The only feature open to serious criticism with this variety is the rather low "tannin" content, which would tend to a low-coloured and rather thin cider. There is little doubt that a cider of very good quality could be made from apple. Its high value for eating purposes makes it unlikely that this sort would ever reach the cider mill, so in considering the use of table fruit for making cider it may be disregarded.

Cider-Making Trials with Market Varieties.

To supplement the laboratory examination of the vintage qualities of apples of this class, cider has been made on a practical scale in the cider-house from some of the varieties mentioned in the above Table which were procurable in sufficient quantity and at an economic price. The number of these tests thus far made is small, but as opportunity occurs it will be increased. In the 1921 season, Bramley's Seedling and Lane's Prince Albert were used: in 1922 those sorts were again tested, with Worcester Pearmain, Warner's King and Newton Wonder in addition. It is still too early to say much of the latter except that they give indication of conforming to the type described in the previous section as characteristic of market fruit. The Worcester Pearmain cider with low acidity already suggests interesting possibilities: being made in October and filtered very early, it is now fit for consumption, although a final opinion on it cannot be given until it has been exposed to summer temperature.

The 1921 ciders from Lane's Prince Albert and Bramley's Seedling ultimately matured to a standard considerably above expectation.

The juices in each case fermented very rapidly and were filtered when ten days old to conserve as much as possible natural sweetness to balance the high acidity. In bottle, after one year, that sweetness has still been in a large measure retained and the ciders are quite sound and in good sparkling condition. The Bramley's Seedling sample is the better, being a clean sharp cider, by no means unpleasant in flavour, although much too acid for use alone. Very good blends with low-acid ciders of the sweet and bitter-sweet classes have been made and it has been found possible to use it with completely satisfactory results on the same lines as ultra-acid ciders made from the sharper vintage varieties. For such purposes it does not compare in quality with the best vintage sorts, but it can fairly be placed on a level with a good average second-class variety. The Lane's Prince Albert cider was of a similar character, but slightly inferior. Its inferiority ought probably not to be attributed to the variety, for the conditions under which the cider was made were unavoidably less satisfactory.

Conclusions.

The conclusions drawn in the preceding sections as to the vintage quality of table varieties of apples will suffice to indicate to the professional cider-maker the manner in which such fruit can be turned to best account by him for cider-making. It his case there is relatively little difficulty, since with all classes of vintage fruit at his command he can readily by judicious blending adjust deficiencies in quality and exercise control over fermentation with his available equipment.

The position is less easy for the market apple grower who desires to convert any surplus of table fruit into cider. For him the problem is how, using such fruit as a basis, to produce a marketable cider. The requirements seem clear. A supply of vintage fruit acidity and fairly high tannin content, i.e., a typical bitter-sweet variety, is needed in sufficient quantity to blend with the table fruit so that the resultant cider shall not possess too much acidity or be too thin in character. The addition of a proportion of vintage fruit will also increase the sugar contents of the freshly pressed juice and lower the rate of fermentation, but unless the proportion added is large it will not help greatly the matter of control of fermentation. Effective control is necessary for the production of cider retaining natural sweetness from juices composed largely of the market fruit element and the only suitable method of securing it which can be recommended at the present time is that of filteration. The high cost of cider filters practically put this method beyond reach of those making small amounts of cider annually and the work needs to be

conducted on a commercial scale for a filter to be economically employed.

Those who desire to turn surplus table fruit to profitable account by conversion into cider must therefore be prepared to purchase or grow a proportionate amount of suitable vintage fruit and to cater for an output suffiiciently large to justify the provision of an efficient filter. If that is done, they can be reasonably sure of being able to produce a cider of sufficiently good quality to bring a fair return on the outlay.

THE COMPOSITION OF VINTAGE APPLES IN 1921.

By Otto Grove.

For some years the practice of publishing the annual analyses of the juices of vintage apples and pears in the Report has been discontinued, the data given in the earlier Reports being regarded as sufficient to indicate the main features of the composition of individual varieties and the fluctuations due to seasonal influence. The summer of 1921 was so abnormal in respect of heat and drought that it is desirable to place on record the results for that year to show the effect of those extreme conditions on the vintage quality of the fruit. A particularly good opportunity of securing results covering a wider area was afforded by the competitions for vintage apples which were held at the Imperial Fruit Show at the Crystal Palace in the autumn of that year, the exhibited fruit being handed over to the Institute for analysis. The results, given in the appended table, may be regarded as supplementary to those included in the previous section of the Report dealing with the ciders made from that season's fruit, in which the seasonal characters are pointed out and need not be recapitulated here.

Variety.	*Specific Gravity of Juice.*	*Acid.* %	*Tannin.* %	*Grower.*	*District.*
Backwell Red	1·064	·61	·08	Research Station ..	Long Ashton.
Bagally's Darling	1·058	·58	·15	Capt. F. W. Crawshay	Hempnall Cider Factory, Norwich
Bedan des Partes	1·058	·15	·32	Research Station ..	Long Ashton.
Bedminster	1·070	·79	·15	Ditto	Ditto.
Black Styre	1·069	·59	·23	E. A. Austin	Baltonsborough, Glastonbury, Somt.
Broadleaf Jersey	1·069	·55	·20	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Broadleaf Norman	1·053	·18	·23	Ditto	Ditto.
Broad Tail	1·064	.23	.20		
Bunch Apple	1·065	·44	·16	F. G. Salisbury	Bridge Farm, Coat, Martock, Somt.
Cap of Liberty	1·061	1·00	·37	Research Station ..	Long Ashton.
Ditto	1·063	·84	·32	E. V. Wheeler ..	Newnham Court, Tenbury, Worcs.
Carrion Apple	1·068	·40	·17	Capt. F. W. Crawshay	Hempnall Cider Factory, Norwich.
Cherry Pearmain	1·059	·59	·23	Research Station ..	Long Ashton.
Cherry Norman	1·060	·18	·17	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Chiffers	1·065	·28	·25	Research Station ..	Long Ashton.
Cowarne Red	1·057	·56	·17	Ditto	Ditto.
Cremiere	1·055	·22	·16	Ditto	Ditto.
Crimson King	1·075	·25	·36	Ditto	Ditto.
Crimson King	1·062	·47	·17	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Dabinett	1·058	·14	·20	Research Station ..	Long Ashton.
Ditto	1·076	·27	·25	E. W. Dabinett ..	Kingweston, Taunton, Somerset.
Davis Crab	1·062	·94	·29	Research Station ..	Long Ashton.
Doux Amer	1·050	·32	·16	Ditto	Ditto.
Dove	1·059	·26	·11	Ditto	Ditto.
Dove's Seedling	1·061	·34	·13	Ditto	Ditto.
Devonshire Bittersweet ..	1·062	·35	·57	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Dymock Red	1·063	·60	·15	Research Station ..	Long Ashton.
Ditto	1·057	·58	·20	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Ecarlatine	1·074	·22	·20	Research Station ..	Long Ashton.

Variety.	*Specific Gravity of Juice.*	*Acid* %	*Tannin.* %	*Grower.*	*District.*
Eggleton Styre	1·081	·18	·15	Ditto	Ditto.
Ellis' Bitter	1·069	·23	·28	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Fair Maid of Devon	1·058	·99	·14	Research Station ..	Long Ashton.
Flashers	1·072	·65	·15	F. G. Salisbury	Bridge Farm, Coat, Martock, Somt.
Foxwhelp	1·054	·53	·23	Research Station ..	Long Ashton.
Ditto	1·057	·87	·13	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
French White Norman ..	1·071	·38	·21	Ditto	Ditto.
Frequin Audievre	1·050	·16	·35	Research Station ..	Long Ashton.
Garter Apple	1·063	·73	·19	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
Gatcombe	1·067	·56	·17	Research Station ..	Long Ashton.
Hagloe Crab	1·057	·56	·14	Capt. F. W. Crawshay	Hempnall Cider Factory, Norwich.
Hangdown Pippin	1·069	·10	·37	Research Station ..	Long Ashton.
Harry Masters Jersey ..	1·053	·17	·23	Ditto	Ditto.
Hurtisman	1·058	1·01	·17	Ditto	Ditto.
Improved Pound	1·080	·18	·20	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Joeby Crab	1·061	1·43	·49	Research Station ..	Long Ashton.
John Day	1·070	·17	·18	Ditto	Ditto.
John White	1·067	·17	·26	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Kingston Black	1·072	·57	·23	Research Station ..	Long Ashton.
Ditto	1·080	·45	·26	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Ditto	1·072	·47	·22	Ditto	Ditto.
Knotted Kernel	1·066	·30	·36	Ditto	Ditto.
Magg's Seedling	1·060	·69	·12	Research Station ..	Long Ashton.
Mediate	1·062	·63	·12	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Monsieur Jacques, No. 1 ..	1·067	·29	·29	Research Station ..	Long Ashton.
Naishes Bitter	1·085	·23	·90	E. A. Austin	Baltonsbury, Glastonbury, Somt.
Neverblight	1·049	·47	·14	Research Station ..	Long Ashton.
Norman	1·070	·29	·42	Ditto	Ditto.

Passe Reine des Pommes	1·083	·30	·69	Research Station	Long Ashton.
Philip Norman	1·056	·25	·17	Ditto	Ditto.
Pom Roy	1·085	·17	·26	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Pople	1·060	1·09	·44	Research Station	Long Ashton.
Port Wine	1·076	·15	·37	E. A. Austin	Baltonsborough, Glastonbury, Somt.
Pride of Australia	1·059	·78	·12	Research Station	Long Ashton.
Pym Square	1·058	·46	·21	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
Rawling's Kernel	1·065	·42	·10	Ditto	Ditto.
Red Bud	1·060	·72	·21	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Ditto	1·069	·63	·15	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
Red Foxwhelp	1·059	·76	·26	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Red Norman	1·048	·18	·17	Ditto	Ditto.
Ditto	1·053	·14	·20	Ditto	Ditto.
Red Streak	1·047	·84	·11	H. R. Spence	Stoke Abbott, Beaminster, Dorset.
Reinette Obry	1·067	·72	·19	Research Station	Long Ashton.
Rouge Bruyere	1·066	·37	·18	Ditto	Ditto.
Siberian Crab	1·092	·15	·18	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Silver Cup	1·079	·21	·41	Research Station	Long Ashton.
Skyrme's Kernel	1·058	·70	·26	Ditto	Ditto.
Somerset Foxwhelp	1·073	·26	·41	E. A. Austin	Baltonsborough, Glastonbury, Somt.
Sour Woodbine	1·069	·37	·16	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Spreading Redstreak	1·060	·96	·15	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
Strawberry Norman	1·065	·20	·41	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
String Pippin	1·057	·60	·11	H. R. Spence	Stoke Abbott, Beaminster, Dorset.
Sweet Alford	1·053	·10	·15	Research Station	Long Ashton.
Ditto	1·057	·21	·30	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
Sweet Broadeye	1·060	·12	·17	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Sweet Coppin	1·061	·26	·16	Research Station	Long Ashton.

Variety.	*Specific Gravity of Juice.*	*Acid* %	*Tannin.* %	*Grower.*	*District.*
Sweet Coppin	1·069	·19	·17	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Sweet Loyal Drain	1·073	·20	·60	E. W. Dabinett ..	Kingsweston, Taunton, Somt.
Sweet Woodbine	1·081	·23	·23	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Tardive Forestier	1·060	·23	·51	Research Station ..	Long Ashton.
Thomas Hunt	1·080	·20	·16	Ditto	Ditto.
Tom Putt	1·058	·73	·17	Ditto	Ditto.
Tremlettes Bitter	1·063	·31	·42	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Upright Red Streak	1·074	·86	·12	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
Victoria	1·063	·17	·17	Research Station ..	Long Ashton.
Virgin Mary	1·076	·18	·30	Ditto	Ditto
Wilding Bittersweet	1·074	·29	·25	E. V. Wheeler	Newnham Court, Tenbury, Worcs.
White Jersey	1·071	·25	·27	Research Station ..	Long Ashton.
White Norman	1·080	·17	·46	Ditto	Ditto.
White Musk	1·052	·23	·19	A. E. Hill	Eggleton Court, Ledbury, Herefordshire.
White Sour	1·056	·58	·11	H. Whiteway & Co., Ltd.	The Orchards, Whimple, Devon.
Wyatt's Seedling	1·075	·49	·27	Ditto	Ditto
Yarlington Mill	1·055	·16	·27	Research Station ..	Long Ashton.
Yeovil Sour	1·057	·57	·28	Ditto	Ditto.

CIDER-MAKING TRIALS FOR THE SEASON 1921-2.

By Otto Grove.

The tables overleaf gives a list of the apples made into cider during the season, with the chemical composition of the different juices and other particulars. As regards the composition of the juices the most interesting fact was the very high specific gravity. The average specific gravity of all the juices was 1.0601. This is much above the normal, which is about 1.050. This feature must be attributed to the very dry and hot weather during the summer and autumn, the drought and heat combined causing the fruit to be of small size and its juice relatively concentrated. This was especially marked with apples from the Martock district, some of the Kingston Black samples received from that part being only about half their normal size. As will be seen from the table, specific gravities over 1.070 were not unusual: in one case it was even 1.090. At the same time the yield of juice was in many cases below 150 gallons per ton of apples, whereas the usual average yield is about 165 gallons per ton.

It might be expected that juices with such high specific gravities would yield exceptionally good ciders. This was, however, not the case. The ciders were not above the normal in respect of flavour and aroma. The characteristic flavour of the different varieties was less pronounced than usual, and the general opinion at the Annual Tasting Day was that of too much "sameness." Some of the Kingston Black ciders had a rather peculiar flavour, difficult to define, but giving one the impression that some of the flavouring bodies were present in too large quantities and affecting the palate too much.

Two table varieties were tried for cider for the first time, namely Bramley's Seedling and Lane's Prince Albert. They both fermented very rapidly and had to be filtered already ten days after they were made, so as to retain some sugar in the cider to balance the high acidity. The Bramley's Seedling gave the best result and

produced a nice clean sharp cider, much too acid in flavour to be used alone but making a very good blend with ciders of the bittersweet class. The cider made from Lane's Prince Albert had similar character but was not quite so good. They have both kept well and are in good condition after one year in bottle.

There were no cases of sickness during the summer, but some samples developed ropiness. From one of the samples a new micro-organism producing ropiness was isolated. This organism is under investigation at the present moment, and it is hoped that further light may be thrown upon the causes of this very troublesome disorder.

Among the varieties of the sharp class used in the trials Nos. 1 and 4 were tested for the first time; they were both fairly good ciders but did not show special merit. Most of the others have been tested several times and were not above the average. Backwell Red, Foxwhelp, Teign Harvey, Frederick and Red Soldier were the best. Of the Kingston Black ciders Nos. 18—22 were rather affected by the peculiar flavour mentioned above. Of the sweet varieties White Beach and John Day were tested for the first time. The first was rather lacking in character, but the second gave a very nice sweet cider, which made a good blend with the table varieties Nos. 28 and 29.

The bittersweet varieties were all rather similar in character, fairly good but without distinction. The best in the group were Nos. 40, 43, 45 and 46.

Of the mixed apples, No. 47 made of apples from one small orchard in Kenn, in Somerset, was very good with a well balanced pleasant flavour. No. 49, which fermented very slowly and was filtered too early, was too sweet but otherwise good.

Only one perry was made during the season and it was not up to the standard for the variety, the pears being rather over-ripe when received.

In the case of the pasteurised juices fermented with pure yeasts, No. 52 was the best. They were all very palatable ciders and the pasteurisation could not be detected in the flavour, but the difference in quality between the control, fermented in the usual way, and the samples fermented with pure yeast cultures was not very pronounced in this case. As it will be seen the pure yeast in the pasteurised juices fermented much more slowly than the natural yeasts in the unpasteurised control sample.

No.	Name of Variety.	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering	Specific Gravity
									May, 1922.
	APPLES—								
	SHARP VARIETIES—								
1	Hampshire Blossom	Hereford	Nov. 16th	1·062	·73	·19	8·4	4/1/22	1·014
2	Butter Box	Newton Abbot	Oct. 20th	1·055	·72	·12	4·7	13/1/22	1.016
3	Crimson King	Martock, Som.	Nov. 22nd	1·071	·88	·15	11·0	3/1/22	1·017
4	Siberian Bittersweet	Hereford	Nov. 16th	1·057	·70	·17	6·4	4/1/22	1·018
5	Bickington Grey	Newton Abbot	Oct. 20th	1·053	·87	·14	4·5	13/1/22	1·021
6	Cherry Pearmain	Byford, Her.	Oct. 28th	1·058	·65	·17	6·1	4/1/22	1·023
7	Skyrme's Kernel	Hereford	Oct. 26th	1·053	·64	·15	3·1	17/1/22	1·025
8	Backwell Red	Backwell, Som.	Oct. 14th	1·054	·68	·10	5·5	13/1/22	1·027
9	Foxwhelp	Ledbury	Oct. 18th	1·054	·87	·23	4·8	13/1/22	1·027
10	,,	Nunnington, Her.	Oct. 31st	1·058	·92	·24	3·0	4/1/22	1·031
11	Red Streak	Hereford	Nov. 16th	1·050	·49	·13	2·5	17/1/22	1·027
12	Teign Harvey	Newton Abbot	Oct. 20th	1·052	·54	·20	3·7	16/1/22	1·028
13	Cap of Liberty	Martock, Som.	Dec. 6th	1·074	·80	·32	3·4	14/3/22	1·031
14	,, ,,	,, ,,	Nov. 8th	1·083	·82	·37	4·2	8/3/22	1·035
15	Frederick	Dingestow, Mon.	Oct. 24th	1·058	·80	·05	2·7	16/1/22	1·031
16	Red Soldier	Hereford	Nov. 23rd	1·056	·83	·18	2·1	7/2/22	1·036
17	Kingston Black	Martock, Som.	Nov. 3rd	1·083	·75	·23	9·0	19/12/21	1·023
18	,, ,,	Kingweston, Som.	Nov. 25th	1·090	·70	·25	8·0	23/3/22	1·027
19	,, ,,	Powick, Wor.	Nov. 23rd	1·080	·66	·18	5·6	10/4/22	1·028
20	,, ,,	Ledbury	Nov. 14th	1·076	·62	·18	5·0	24/3/22	1·029
21	,, ,,	Nunnington, Her.	Nov. 7th	1·074	·51	·19	4·0	6/4/22	1·030
22	,, ,,	Moorhampton, Her.	Nov. 11th	1·068	·59	·15	2·9	14/3/22	1·030
23	,, ,,	Hereford	Nov. 7th	1·074	·58	·19	4·4	30/1/22	1·032
24	,, ,,	Yatton, Som.	Nov. 8th	1·080	·81	·19	5·5	11/4/22	1·032

No.	Name of Variety.	District where Grown.	Date of Making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering	Specific Gravity.
25	,, ,, ...	Breinton, Her. ..	Nov. 1st	1·059	·55	·16	3·6	30/1/22	1.032
26	,, ,, ...	White Lackington, Som. ..	Nov. 1st	1·062	·55	·19	3·4	29/1/22	1·033
27	,, ,, ...	Byford, Her. ..	Oct. 28th	1·066	·56	·16	4·5	3/1/22	1·038
	Culinary Varieties—								
28	Lane's Prince Albert ..	Lincs.	Dec. 12th	1·047	·93	·10	7·8	22/12/21	1·028
29	Bramley's Seedling.. ..	,, ...	Dec. 12th	1·050	1·01	·14	5·0	22/12/21	1·034
	Sweet Varieties—								
30	White Beach	Hereford	Nov. 16th	1·048	·43	·12	4·0	4/1/22	1·017
31	Sweet Alford	Newton Abbot ..	Oct. 20th	1·056	·39	·16	4·8	13/1/22	1·016
32	,, ,, ...	Long Ashton, Som.	Nov. 2nd	1·050	·19	·13	3·5	17/1/22	1·018
33	Sweet Blenheim	Martock, Som. ..	Nov. 22nd	1·073	·36	·25	7·7	18/1/22	1·022
34	John Day	Yatton, Somerset	Oct. 7th	1·062	·36	·20	4·2	13/1/22	1·023
	Bittersweet Varieties—								
35	Frequin Audievre	Long Ashton, Som.	Dec. 13th	1·039	·20	·21	5·2	18/1/22	1·008
36	Strawberry Norman ..	Hereford	Nov. 4th	1·055	·42	·31	7·5	3/1/22	1·018
37	,, ,, ...	Ledbury	Nov. 16th	1·060	·37	·34	6·5	14/1/22	1·025
38	White Norman	Nunnington, Her.	Oct. 14th	1·051	·21	·28	5·0	13/1/22	1·020
39	Styre Wilding	,, ,, ..	Nov. 11th	1·066	·23	·14	6·5	12/1/22	1·022
40	Thomas Hunt	N. Cadbury, Som.	Nov. 30th	1·070	·31	·29	6·5	2/2/22	1·025
41	Pocket Apple	Newton Abbot ..	Oct. 20th	1·057	·39	·22	4·2	14/1/22	1·025
42	Handsome Norman ..	Ledbury	Nov. 15th	1·060	·25	·27	5·3	1/2/22	1·025

	Bittersweet Varieties—(Continued).									
43	Knotted Kernel	Byford, Her. ..	Oct.	21st	1·060	·31	·28	4·5	14/1/22	1·026
44	White Jersey	Churchill, Som. ..	Sept.	20th	1·056	·25	·35	3·3	1/10/22	1·033
45	Royal Wilding	Ledbury	Nov.	15th	1·061	·32	·20	4·6	1/2/22	1·033
46	Cherry Norman	Dingestow, Mon...	Oct.	26th	1·060	·25	·27	3·0	4/1/22	1·034
	Mixed Apples—									
47	Mixed Apples	Yatton, Som. ..	Nov.	1st	1·057	·84	·19	3·3	13/1/22	1·033
48	,, ,, ...	Newton Abbot ..	Oct.	21st	1·055	·51	·16	4·4	16/1/22	1·026
49	,, ,, ...	Hereford and Martock	Dec.	9th	1·066	·69	·23	4·7	17/1/22	1·050
	Perry—									
50	Oldfield	Twigworth, Glos.	Oct.	21st	1·058	·91	·09	3·1	15/12/22	1·030

Pure Yeast Experiment.

The juice from a mixture of Apples (Cap of Liberty, Kingston Black and Strawberry Norman) was pasteurised for five minutes at a temperature of 165°F. and fermented with pure yeasts.

51	Control (not pasteurised)	Dec.	9th	1·069	·64	·27	4·5	13/3/22	1·024
52	Fermented with Yeast No. 6 (Kingston Black)	,,		,,	,,	,,	,,	26/4/22	1·030
53	,, ,, ,, No. 8 (Romeril B.) ..	,,		,,	,,	,,	,,	3/4/22	1·025
54	,, ,, ,, No. 31 (Rüdesheimer)..	,,		,,	,,	,,	,,	25/4/22	1·027
55	,, ,, ,, No. 32 (Steinberg) ..	,,		,,	,,	,,	,,	25/4/22	1·028

RESEARCH WORK ON WILLOWS.

By H. P. Hutchinson.

Although willows and osiers have been grown for basket making purposes in this country for many centuries, little scientific attention has yet been paid to the industry. Beyond the discovery of the buffing process, about the year 1860, and some improved methods of cultivation arising from the use of improved agricultural implements, few advances in methods of production have been made since the Roman times.

The economic importance of the industry may be guaged from the fact that in 1920 the annual value of the imports of willows and and canes for basket making purposes was £592,718 and of manufactured baskets and basket ware £557,351.

Further, large areas of suitable willow growing land (much of which is now unproductive), exist, chiefly in the low lying parts of river valleys and coastal districts of the country, which might be devoted to willow cultivation. In many parts both soil and climate are particularly suited to the growing of the best varieties; thus the area under willow cultivation might be profitably extended.

Support is given to this view from the fact that of late years there has been a decline in the country's production of willow rods, chiefly due to neglect in cultivation of willow beds during the war years. Large quantities of willows are now imported from France, Belgium and Holland, so that with improvements in trade, which are anticipated, it is likely that English basket makers will be compelled to rely largely on imported rods for material and the public on foreign made baskets owing to the scarcity of home grown willows which, with a continuation of present conditions, is likely to arise.

In addition to reduced acreage, the yields of willows are now considerably impaired by injuries caused by various fungi and insect pests. Records show that such attacks have frequently occurred in the past; but of late years, owing to lack of knowledge of effective remedies, these pests have become so firmly established in important willow growing centres, as to cause financial losses in the cultivation of the crop. In some cases, the virulency of the attacks has thrown willow beds completely out of cultivation.

The Station, through its officer, provides advice on all matters connected with the cultivation and management of the crop.

Scientific investigations at the Research Station have been arranged on the following lines.

Classification.

A willow plantation comprising all the commercial varieties of basket willows grown in this country will be laid out. Identification will then be possible and reliable information obtained on quality and other characters of the rods of the various varieties. The suitability of varieties will be determined for varying soil conditions and for the making of the different types of basket ware. The plantation will serve as a source of supply of cuttings true to name and free from disease and will also provide material for research purposes in connection with the preparation of rods for use.

Insect and Fungoid Pests.

Willow growers and basket makers regard this branch of the work as of considerable importance, and their co-operation will be given to experimental trials which will be carried out in the field. The life histories and habits of the insects and fungi concerned being at present imperfectly known, an extensive scientific enquiry is needed before practical remedies can be ascertained

Fungoid attacks, causing depreciation in value, which occur on rods during their period of preparation and later storage, of which scientifically little is known, will be investigated with a view to the discovery of remedial measures.

Preparation of Rods for Use.

The method now employed for peeling willows is tedious, slow and expensive. Hence the high cost of production results in high prices to the basket-maker for material and subsequently in high prices to the public for baskets.

Experimental work will be undertaken with a view to reducing costs of production by improving willow peeling processes.

Peeled willow rods are now marketed in two colors only, viz., "White" and "Buff." By investigation of willow bark products it may become possible to induce the formation of various colored rods for commercial purposes.

Manurial Treatment.

Little information exists in regard to manurial requirements of the willow crop. As it is probable that varying constituents of plant food affect yield and quality of rods, a scheme of manurial treatment has been devised for the obtaining of information which will enable willow growers to apply the manures most suited to the crop's requirements.

ADVISORY WORK.

The number of enquiries received by post during the year ending September 30th, 1922, was 478, thus showing an increase of 107 over last year. The figures for the counties as well as totals and the corresponding figures for the previous four years are set out as below :—

	Year ending Sept. 30th.				
	1918	1919	1920	1921	1922
Gloucester (including Bristol) ..	21	29	53	73	78
Hereford	2	6	10	22	21
Somerset	46	75	79	96	114
Wiltshire	0	6	3	10	18
Worcester	11	11	29	45	46
Other areas	93	75	117	123	201
	173	202	291	371	478

The figures for "other areas" include Devon and Monmouth, which counties contribute an annual grant to the Institute. Both entomological and mycological questions have been fewer than last year, but their number is more than made up by the increase in chemical and cider questions, the latter being especially numerous.

In addition to the advisory work indicated by the fore-going enquiries by correspondence, a very considerable amount, of which no statistics can be given, has been dealt with verbally. Matters raised by visitors to the Station or by growers visited during the course of tours in the Province come under this head.

Nature of Inquiries.

Fruit Products.—The advisory work in connection with the cider and perry and other fruit-products shows considerable increase. 177 written enquiries were dealt with, some of them entailing analyses of apples, determination of alcohol, sugar, etc. The sources of the enquiries are set out below.

Gloucester	15
Hereford	9
Somerset	33
Wiltshire	1
Worcester	13
Other Areas	106

Besides the enquiries received by post many people visited the Research Station to see the experimental cider factory and receive information.

Some enquiries were received concerning the use of market apples for cider, a subject which is receiving a good deal of attention by fruit growers.

Several cider factories and orchards were visited and a special examination of and fermentation experiments with six different fruit juices from the Agricultural College in Poona (India) were carried out.

As an example of the nature of the enquiries, the following analysis of the more general points dealt with may be of interest :—

Cidermaking in general (including Perrymaking)	5
Ropiness of Cider	3
Racking and Filtration	6
The Use of Preservatives	3
Bottling	5
Analysis of Cider and Perry	11
Fermentation	2
Machinery	8

The rest of the enquiries were mostly concerned with special problems of cider-making.

It is noteworthy that fourteen enquiries came from countries outside Great Britain and Ireland, viz., France, Russia, New Zealand, India, South Africa and the U.S.A.

Mycological.—During the year, the number of enquiries received was somewhat fewer than in the previous year and were distributed among the counties as follows :—

Gloucester	17
Hereford	3
Somerset	19
Wiltshire	1
Worcester	8
Other Areas	22
	70

As usual the enquiries covered a very large field, many of them being concerned with very obscure diseases.

There has been no very striking characteristic of the past season from the mycological point of view, but a few diseases have been more prominent than usual. Firstly, a number of cases were met with in which the buds of the pear and also of the apple were affected. Sometimes the buds were killed off before the flower buds opened and at others when they were full open. A preliminary study of these diseased buds was made, with the intention of following the matter further. In a number of instances *Nectria galligena*, the canker fungus, was isolated from the buds both on the pear and on the apple. This occurence was very surprising and further attention should be given to this type of infection. In other cases the blossom bacillus was present, causing definite scars down the side of the stem which did not progress more than a few inches. From the fact that

unopened flower buds were sometimes killed off by this organism it appeared that the infection probably developed from the isolated colonies of the bacillus which are known to occur in the spur shoots. The species of Fusarium causing bud rot was present in some cases but not very frequently. On one special tree of the Lord Suffield variety at Long Ashton, many infections of this organism have been found in which the bud was not only killed but the fungus had grown back into the main stem, producing a scar about 1 or 2 inches long. On the dead shoot left, pink spore pustules of the fungus were produced during the summer (July). In the Ministry of Agriculture's Leaflet on canker, the pustules of the canker fungus were referred to as pink or white and it is probable that the spore pustules belonging to the Fusarium Bud Rot fungus were referred to. In some cases the cause of the dying of the buds remained obscure, especially was this the case in some of the pears. A careful examination of the developing buds, however, showed that in a number of cases, the cortical tissue was killed in a zone extending completely round the base of the flower shoot, and about $\frac{1}{8}$ of an inch wide, but never very deep into the tissue. The result was, however, the wilting and death of the whole flower shoot very quickly. No organism was isolated from these specimens and the cause remains completely unknown. As a result of this preliminary investigation it is evident that diseases of fruit buds would amply repay further investigation.

One peculiar disease of raspberry canes was recorded from Worcestershire, where it was doing severe damage in a garden. The canes became quite black owing to the growth of a dark coloured fungus mycelium in the bark. The tissues of the main stem appeared to be healthy in most cases, and whether the fungus present was causing the disease is unknown. No fructifications of the fungus were discovered.

An unusual condition in the strawberry crop was the prevalence of mildew, which attacked particularly young vigourous growth.

Sclerotinia apivorum was recorded on land which had not grown onions for 10 years. Information was sought but was not obtained as to the cause of the discontinuation of the culture of onions previously.

Sclerotinia sclerotiorum was found doing very severe damage on cucumber and *Sclerotinia trifoliorum* on beans.

Armillaria mellea continues to be the cause of a few enquiries each year. This time it is reported on privet—destroying a carefully kept hedge—on black currants and red currants.

A number of enquiries were also received regarding the non-parasitic blossom-end rot of tomatoes. One case occurred in which salt water had been used in watering the plants on account of the drought and where the disease occurred very badly. This supported

the view that bad water supply is responsible for this disease, although the fact that the soil was acid at the same time did not allow of any exact conclusion being drawn.

Sleepy disease of tomatoes was traced to *Verticillium albo atrum*.

The Chocolate Leaf Spot was reported as doing damage in Wiltshire, but there was not general epidemic as in 1920. A point which was noticeable with regard to the potato leaf curl was the bright colouring of the foliage, identical with the colouring which occurs on the Continent, but which is not often seen in the West of England. The drought of the early summer may have been responsible for this effect.

An obscure disease of vegetable marrows was noted towards the end of July. The leaves became variegated with yellowish blotches and then remained small. Single plants were infected, whilst the surrounding ones were healthy. The fruits were not developed properly having a very uneven surface. No fungus was found to be present and although the reason was sought in the extremely cold nights experienced in the early part of July, yet the fact that some plants were affected and not others led one to regard this view with suspicion. The appearance of the plant suggested a mosaic disease, but no evidence of this was obtained.

Pomological.—During the year 78 replies were given by letter, while many growers visited the Station for information on definite points.

Sources of written enquiries :—

Gloucester (including Bristol)	17
Hereford	2
Somerset	16
Wiltshire	3
Worcester	4
Other Areas	36
	78

A large percentage of the enquiries referred to strawberry-growing, many to varieties of fruits for identification and the remainder to general fruit culture.

The prominence of the strawberry-growing enquiries is due probably to the comparatively large programme of experiments with this crop at present being carried out at Long Ashton. The Cheddar Fruit Growers' Association may be mentioned as being particularly interested in this work as well as many prominent growers from other strawberry districts not in the advisory area.

The majority of enquiries on strawberry culture were concerned firstly with remedies for the several forms of stunted plants which are causing the growers serious losses in many parts of the country;

and secondly with the commercial value of the newer varieties. On the latter point the Station has started a series of variety trials in conjunction with the Cheddar Fruit Growers' Association.

Shows.—An exhibit from the Station was sent to the following Shows :—

(1) The Imperial Fruit Show at the Crystal Palace.

(2) The Bath and West at Plymouth.

The following sections dealing with the Advisory work in Agricultural Chemistry and Economic Entomology have been contributed respectively by Mr. T. Wallace and Mr. A. H. Lees, the advisors in these subjects.

Agricultural Chemistry.

During the year 76 requests for advice have been received. The sources and nature of these enquiries, together with their special points of interest, are given below :—

SOURCES OF ENQUIRIES.

Gloucester (including Bristol)	21
Hereford	4
Somerset	22
Wiltshire	10
Worcester	11
Other Areas	8
	76

NATURE OF ENQUIRIES.

(1) *Soil Problems.*

(*Soil Manurial Problems*).

Pastures and Meadows	12
Arable Soils	19
Fruit Soils	7
Garden Soils	4
Hop Garden Soils	1
Total	43

(*b*) *Miscellaneous Soil Problems.*

Soil conditions in cases of "Leaf Scorch"	12
Suitability of Soils for Apple Growing	5
Ditto Strawberry growing	1
Examinations of Soils for Lead	2
Soil conditions in cases of failures of tomato crops	2
Soil conditions in cases of failures of crops on arable land	17
Soil conditions where soil appears to be unsuitable for fruit growing	2
Total	41

(2) *Miscellaneous Enquiries.*

Agricultural value of samples of lime, chalk and limestone	5
Agricultural value of residues from a Calcium Carbide plant	1
Potash contents of samples of wood ashes ..	3
Purchase of Manures	2
Fradication of Horsetail from Pastures ..	2
TOTAL	13

OBSERVATIONS ON ENQUIRIES.

(1) *Soil Enquiries.*

In dealing with the enquiries submitted seventeen farms have been visited and seventy samples of soil have been examined. The majority of the enquiries may be grouped under three headings :—

(1) Enquiries relating to the best methods of improving grassland.

(2) Enquiries as to the causes of crop failures on arable land.

(3) Enquiries relating to fruit-growing.

In connection with grassland improvement problems efforts are being made to collect soil data in cases where farmers are endeavouring to effect improvement by applications of basic slag. It is felt that in such cases data relating to the lime requirements of the soils are of importance in this Province as the lime requirements of many of the poor pastures situated on the various Sandstone Formations are very high : several such cases are now under observation.

As in previous years a large percentage of the cases of crop failures examined appear to be due to acid conditions in the soils. The majority of these acid soils were found to be situated on either the Upper Greensand Formation or the Old Red Sandstone Formation.

The most pressing problem of the fruit-growing areas which appears to be intimately connected with soil conditions is the problem of " Leaf Scorch." Twelve cases of this disease have been submitted by growers and many more cases have been observed during a special tour made in August of certain fruit-growing areas in Herefordshire and Worcestershire. This problem is receiving special attention at this Station at present and during the course of last season many samples of soils from " Leaf Scorch " plantations have been examined and several manurial trials have been arranged in the two above mentioned counties.

(2) *Miscellaneous Enquiries.*

As in previous years most of these have related to the values of samples of lime, wood ashes, etc.

From enquiries received on the questions of lime and liming and from private conversations with farmers on this subject it is clear

that great benefit would be derived by Agriculturists from a reduction in the current prices of lime and limestone.

Special Investigations in Progress.

(1) Field Experiments on "The Eradication of Bracken from poor Moorland Pastures."

This experiment has been continued over the past season. The results obtained will appear in the Journal of The Bath and West and Southern Counties Agricultural Society.

(2) Experiments to ascertain the cause of dying off of strawberry plants in the Tamar Valley area.

These experiments have been continued.

(3) Experiments on Chlorosis with reference to a case at Winscombe, Somerset.

The experiments on this subject have been concluded during the past season. The results will appear in the Annual Report of the Research Station for 1922.

Experimental Work under Consideration for Season 1923.

(1) Field Experiments on "The Effect of Dressings of Sulphate of Potash on Leaf Scorch."

Arrangements are being made to carry out experiments at several centres in Worcestershire in co-operation with the Agricultural Organiser and at three centres in Herefordshire in co-operation with the growers concerned.

(2) Field Experiments on "The Effect of Dressings of Phosphatic Manures in Preventing Early Defoliation of Fruit Trees."

It is proposed to carry out this experiment at one centre in Worcestershire which appears to be suitable for this purpose. The experiment is being carried out primarily with the object of testing under field conditions results which have been obtained in pot experiments at the Research Station.

(3) Manurial Experiments on Apple Trees—variety, Cox's Orange Pippin—where trees do not fruit satisfactorily.

The experiments are to be carried out at one centre in Worcestershire.

Visits.

Worcestershire and Herefordshire.—During the latter part of August fruit plantations in several of the fruit-growing districts in Worcestershire and Herefordshire were visited. The primary object of the tour was to study the soil conditions in various plantations in which Leaf Scorch was present.

As a result of the visit the soil conditions of twelve of the Leaf Scorch areas are being studied and experiments are being laid down at several centres.

It may be stated that on this visit Leaf Scorch was observed to be present on soils of widely differing textures.

Wiltshire.—During August several farms in Wiltshire were visited with the County Agricultural Officer to examine several cases of crop failures. Most of the cases related to soils situated on the Upper Greensand Formation and in all of these cases the cause of the failure appeared to be due to soil acidity.

Two other cases of interest were examined, one being a case of the failure of turnips on newly ploughed out Downland and the other a case of a poor pasture.

In the first case, on the small patches where plants had made any growth, the plants were showing symptoms of potash starvation. Since this field was visited the farmer has sown the failure patches with rye, but the plants after making a little growth have died down from their tips.

The Agricultural Officer is endeavouring to arrange for the land in question to be treated with a potash manure.

In the second case there was an area of about 90 acres of land situated on the Oxford Clay, classed as pasture, but over a large part of this area there was no grass to be seen, the surface being covered with dried out moss and stunted gorse bushes. The remainder of the area was covered with rough bent grass and there was a thick " mat " present. The land under question had been previously drained, but the treatment had not produced any beneficial result.

The soil over the area, in spite of recent heavy rains, was exceedingly dry.

Samples of the surface soil were taken from patches where grass was present and where only moss was present. The soil from the former patches was found to have a lime requirement of 1.37% and that from the latter a lime requirement of 1.41%. The condition of the pasture is doubtlessly due to the exceedingly high acidity of the soil.

Economic Entomology.

The sources of enquiries received were as follows :—

Gloucester	6
Hereford	3
Somerset	18
Wiltshire	3
Worcester	8
Other Areas	25
	63

The subjects dealt with were as follows :—

Insects	33
Sprays	6
Diseases	12
Fruit questions	7
Miscellaneous	5

Under the heading " Insects " all other economic groups, such as Myriapoda, Arachnida and Mollusca are included.

Otiorrhyncus picipes was found causing extensive damage to grafts in a nursery. In Herefordshire it was found causing unusual damage to black currants. The weevils as usual spent the day under clods of earth, but at night ascended the growing shoots and bit them nearly through. The shoots thus fell over and wilted. This took place in the early summer with the result that the shoot became much branched and useless.

A somewhat similar result may be produced by the attacks of a Tortrix caterpillar which eats out the terminal bud and causes extensive growth of the lateral buds. This is of comparatively common appearance in black currant plantations and is sometimes put down to reversion from which it is however quite distinct.

Galls of *Lasioptera rubi* were again sent in this year, on this occasion from Gloucestershire.

Enquiries on methods of control of White Fly in greenhouses were comparatively numerous. On the whole, however, the attacks seem to be lessening.

" Diseases " indicates maladies other than those caused by fungi and insect pests. Besides enquiries on Reversion Disease of Black Currants information has been sought on cases of strawberries dying for unaccountable reasons and on virus diseases of raspberries.

Amongst the former are cases of so-called " Red Plant " of strawberries, the position of which is still very obscure.

The number of enquiries shows a reduction of 34% on last year's figures.

Visits.

Southampton Districts.—A visit was made to this district for the purpose of investigating the diseases of strawberries known as " Red Plant." The trouble appears to be abundant on the lighter soils which have been under intensive strawberry cultivation for some years. The symptons of the disease are very obscure and confusing, especially as the trouble seems to be accentuated by soil peculiarities. The problem clearly calling for special research work in combination with field work in the affected areas, arrangements have now been made for detailed investigations.

Pershore and Hereford Districts.—Visits to plantations in these two districts revealed a very large amount of apple Leaf Scorch. This disease was far more prevalent than usual. The heavy crop of 1921 and the strong drought coupled with a second heavy crop in 1922 had evidently thrown a considerable strain on the trees. This strain was shown by scorching of the leaves and by a peculiar yellowing in the leaf margin that appears to be a forerunner of scorch. This stage was frequently shown by plums.

The heavy cropping might not have been sufficient by itself to produce scorch or yellowing, but coupled with the serious manurial deficiencies found by the Soil Chemist provides a sufficient explanation. Undoubtedly at the present moment, speaking broadly, the manurial question is of more importance to the fruit grower in these districts than pest control.